Electrical (46.0399) T-Chart

Utilize geometric formulas = **Understand and apply the Pythagorean Theorem to solve problems**

Program Task: Calculate the needed angle supports to design and build electrical equipment.

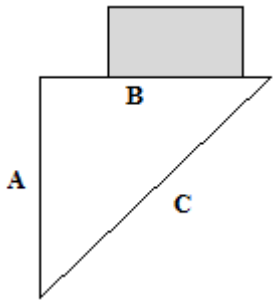
Program Associated Vocabulary:
PYTHAGOREAN THEOREM, HYPOTENUSE, ANGLE

Program Formulas and Procedures:
Electricians use transformers on most commercial/industrial job sites. Transformers are large and heavy pieces of electrical equipment. An electrician will usually attempt to place the transformer on the wall (this of course depends on the size) to be able to keep the electrical room floor free, and provide more room for equipment, such as switch gear, and air handler units.

Angle iron or unistrut are the materials of choice when hanging a transformer, or any type of heavy equipment, on a wall for support.

An electrician will usually place a piece of angle iron under the horizontal leg length (B) of the transformer. Then a vertical leg piece (A), usually the same length, will be bolted to the wall for support. The final angled leg, or the hypotenuse (C), has to be calculated and added for the actual strengthening of the support bracket.

Pythagorean Theorem:
$a^2 + b^2 = c^2$



Example:
If the two known supports (a and b) of a transformer bracket measure 4.5 feet each, what is the measurement needed for the hypotenuse angle (c)?

$4.5^2 + 4.5^2 = c^2$

$20.25 + 20.25 = c^2$

$40.5^2 = c^2$

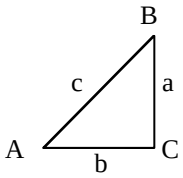
6.36 foot piece of angle iron is needed.

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, 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 triangle 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.

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

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

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

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.

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

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

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

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

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

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

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

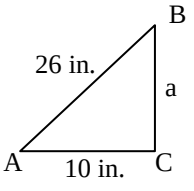
Instructor's Script – Comparing and Contrasting
In the example shown on the Electrical Occupations side of the T-Chart, the student must be able to use the Pythagorean Theorem to solve for the diagonal, C. In many CTE applications, the diagonal is the missing dimension of the triangle. It is also important 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 the students with the ability to use the Pythagorean Theorem in other settings.

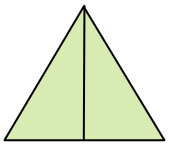
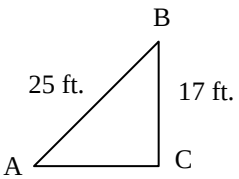
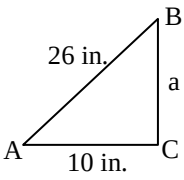
Common Mistakes Made By Students
Incorrectly identifying a, b, and c: Students often confuse the hypotenuse with one of the legs or incorrectly substitute values into the equation. To avoid this problem recognize that the diagonal often is used to describe a hypotenuse. Label your hypotenuse right away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

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
Given a right triangle, this formula can be used with any two measurements that require the third measurement to be found.

Problems	Career and Technical Math Concepts	Solutions
1. A boom lift must reach to the top of a large oil tank. The height of the tank is 55 feet. The electrician must keep the lift 30 feet away from the tank because of the retention ring. How big of a boom lift must be ordered to reach the top safely? *Lifts only come in multiples of 20 foot lengths*		
2. If an electrician was going to hang a transformer that has a horizontal leg measurement of 4' 3" and a vertical leg measurement of 5' 1", what is the hypotenuse measurement for this transformer bracket?		
3. A plant is going to install a new conveyor belt on top of a wall. The top of the wall is 57 feet off the ground, and the bottom of the new belt is going to hit the ground 41 feet away from the wall. How long is the new conveyor belt?		
Problems	**Related, Generic Math Concepts**	**Solutions**
4. A tent has two slanted sides that are both 5 feet long and the bottom is 6 feet across. What is the height of the tent in feet at the tallest point?		
5. Three sides of a triangle measure 9 feet, 16 feet and 20 feet. Determine if this triangle is a right triangle.		
6. On a baseball diamond, the bases are 90 feet 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 m. and 15 m. 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 17feet, 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. A boom lift must reach to the top of a large oil tank. The height of the tank is 55 feet. The electrician must keep the lift 30 feet away from the tank because of the retention ring. How big of a boom lift must be ordered to reach the top safely? *Lifts only come in multiples of 20 foot lengths*		$a^2 + b^2 = c^2$ $55^2 + 30^2 = c^2$ $3025 + 900 = c^2$ $3925 = c^2$ $62.65 = c$ An 80 feet boom lift is required.
2. If an electrician was going to hang a transformer that has a horizontal leg measurement of 4' 3" and a vertical leg measurement of 5' 1", what is the hypotenuse measurement for this transformer bracket?		Convert 4'3" = 4.25' and 5'1" = 5.08' $a^2 + b^2 = c^2$ $4.25^2 + 5.08^2 = c^2$ $18.0625 + 25.8064 = c^2$ $43.8689 = c^2$ Take the square root $\sqrt{43.8689} = 6.62'$ 6.62' ≈ 6' 7" piece needed.
3. A plant is going to install a new conveyor belt on top of a wall. The top of the wall is 57 feet off the ground, and the bottom of the new belt is going to hit the ground 41 feet away from the wall. How long is the new conveyor belt?		$a^2 + b^2 = c^2$ $57^2 + 41^2 = c^2$ $3249 + 1681 = c^2$ $4930 = c^2$ $70.213 = c$ 70.2 feet long
Problems	**Related, Generic Math Concepts**	**Solutions**
4. A tent has two slanted sides that are both 5 feet long and the bottom is 6 feet across. What is the height of the tent in feet at the tallest point?		$a^2 + b^2 = c^2$ $a^2 + 3^2 = 5^2$ $a^2 + 9 = 25$ $a^2 = 16$ $a = 4$ 
5. Three sides of a triangle measure 9 feet, 16 feet and 20 feet. 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 feet apart. What is the distance from home plate to second base using a straight line?		$90^2 + 90^2 = c^2$ $8100 + 8100 = c^2$ $16200 = c^2$ $\sqrt{16200} = c$ 127.28ft. = c
Problems	**PA Core Math Look**	**Solutions**
7. The lengths of the legs of a right triangle measure 12 m. and 15 m. 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 17feet, 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.