

**Find missing dimensions**

**Verify and apply geometric theorems as they relate to geometric figures**

**Program Task:** Determine the size of structures to assist with completion of the job.

**Program Associated Vocabulary:**  
AREA, HEIGHT, PERIMETER, CIRCUMFERENCE

**Program Formulas and Procedures:**  
Electricians have many jobs that must be accomplished on a daily basis. Knowing how much material is needed to complete these jobs is essential.

To ascertain the amounts of materials needed to complete specific projects, electricians may need to determine specific lengths, widths, areas, and/or circumference.

**Example:**  
An electrician has to run conduit up the side of a large oil holding tank. The name plate on the tank states it has a volume of 500,250 cubic feet, with a diameter of 40 feet. How much conduit will be needed to finish this project?  
Hint: Find the height of the tank first.

$$V = 3.14 \times \text{radius squared} \times \text{height}$$

$$\text{Radius} = \text{diameter} \div 2$$

$$\text{Radius} = 40 \text{ feet} \div 2 = 20 \text{ feet}$$

$$500,250 = 3.14 \times (20 \times 20) \times h$$

$$500,250 = 3.14 \times 400 \times h$$

$$500,250 = 1256 \times h$$

$$\frac{500250}{1256} = \frac{1256h}{1256}$$

$$398.29 \text{ ft.} = h$$

The electrician will need 400 feet of conduit to finish this job.

**PA Core Standard:** CC.2.3.HS.A.3

**Description:** Verify and apply geometric theorems as they relate to geometric figures.

**Math Associated Vocabulary:**  
PERIMETER, CIRCUMFERENCE, AREA, VOLUME, OPPOSITE OPERATIONS, POWERS, ROOTS, VARIABLE

**Formulas and Procedures:**  
Given a formula, the student should be able to solve for the missing linear dimension. To do this, the student must use opposite operations.

<b>Opposite Operations</b>	Addition & Subtraction
	Multiplication & Division
	Powers & Roots

**Example 1:**  
Find the length of a cube whose volume is 540 cu. ft., whose width is 6 feet and whose height is 20 feet.

**Step 1:** Identify the appropriate formula  
 $V = l \times w \times h$

**Step 2:** Substitute given values into the formula  
 $V = l \times w \times h$   
 $540 = l(6)(20)$

**Step 3:** Solve for the missing variable by using opposite operations  
 $540 = l(6)(20)$   
 $540 = l(120)$   
 $\frac{540}{120} = \frac{l(120)}{120}$   
4.5 ft. = length

Divide both sides by 120 (opposite operation to multiplication).

**Example 2:** Find the radius of a cylinder whose height is 4 inches and whose volume is 62.8 cu. in.

**Step 1:** Identify the appropriate formula  
 $V = \pi r^2 h$

**Step 2:** Substitute given values into the formula  
 $V = \pi r^2 h$   
 $62.8 = (3.14)r^2(4)$   
 $62.8 = 12.56r^2$

**Step 3:** Solve for the missing variable by using opposite operations  
 $62.8 = 12.56r^2$   
 $\frac{62.8}{12.56} = \frac{12.56r^2}{12.56}$   
 $5 = r^2$   
 $\sqrt{5} = \sqrt{r^2}$   
2.24 = r

Divide both sides by 12.56 (opposite operation to multiplication).

Take the square root of each side (opposite operation to 2<sup>nd</sup> power).

### Instructor's Script – Comparing and Contrasting

Area, perimeter, surface area, and volume are important concepts for many CTE programs. In many cases, the student is asked to calculate one of these measurements, but is not asked to find a missing dimension. It is equally as important for a student to be able to find the height of a cylinder such as a pipe or tank, as it is for them to be able to find the volume. This concept or skill is easy for any CTE instructor to integrate if he/she already integrates area, perimeter and volume calculations. This skill requires the student to recognize the shape and select the appropriate formula, and then substitute values into a formula and solve for a missing variable.

### Common Mistakes Made By Students

#### Selecting the appropriate formula:

- Students need to identify the shape of the figure and then select the appropriate formula.
- Students often mistakenly use volume formulas when they should be using area formulas.

#### Applying the opposite operation to solve for the missing dimension:

- Students have difficulty understanding that taking the square root of a number is the opposite of squaring the number.

#### Using the correct order when using the opposite operation:

- If there is a constant on the side with the variable, the student must add or subtract the constant before dividing by the coefficient.

**Example:** Find the length of a rectangle whose perimeter is 200 feet and whose width is 12 feet.

$$P = 2l + 2w$$

$$200 = 2l + 2(12)$$

$$200 = 2l + 24 \quad \leftarrow \text{At this point in the solution process, the student must subtract 24 before dividing by 2!}$$

$$176 = 2l$$

Length = 88 feet

### CTE Instructor's Extended Discussion

Helping your students learn the formulas, and making them figure out the math will give them some of the tools needed to become a successful tradesperson.

# Electrical (46.0399) T-Chart

Problems	Career and Technical Math Concepts	Solutions
1. Lights must be installed around a self-storage building. The perimeter of the building is 900 feet. If the length of the building is 400 feet, find the width. How many lights will be needed if they are to be placed every 15 feet around the building?		
2. A light manufacturer states that each high pressure sodium light will illuminate an area of approximately 125 square feet. How many lights will be needed to effectively light a warehouse that has a total square footage of 17,000? If the length of the rink is 200 feet, what is the width?		
3. An electrician has to ascend to the top of a concrete silo to change a light. The silo has a cubic feet of 15,000, with a radius of 10 feet. How high will the boom need to reach to safely get to the light?		
Problems	Related, Generic Math Concepts	Solutions
4. What is the radius of a cylinder, whose height is 3 inches and which holds 35 in. <sup>3</sup> of fluid?		
5. A family would like to build a fence in their backyard to give their dog room to run. They will attach the fence to either side of the house (34 feet). How long should the fence extend to give the dog 300 ft. <sup>2</sup> of running room?		
6. A family has 150 feet of fencing to fence in their garden. If their garden will have a length of 30 feet, how wide can they make it?		
Problems	PA Core Math Look	Solutions
7. Find the radius of a circle whose circumference is 20 feet.		
8. Find the radius of a circle whose area is 45 in. <sup>2</sup> .		
9. Find the height of a cylinder whose volume is 300 ft. <sup>3</sup> and whose radius is 6 ft.		

Problems	Career and Technical Math Concepts	Solutions
1. Lights must be installed around a self-storage building. The perimeter of the building is 900 feet. If the length of the building is 400 feet, find the width. How many lights will be needed if they are to be placed every 15 feet around the building?	$900 = 2l + 2w$ $900 = (2 \times 400) + 2w$ $900 = 800 + 2w$ $100 = 2w$ $50 = w$ $900/15 = 60$	60 lights are needed for this job.
2. A light manufacturer states that each high pressure sodium light will illuminate an area of approximately 125 square feet. How many lights will be needed to effectively light a warehouse that has a total square footage of 17,000? If the length of the rink is 200 feet, what is the width?	$A = lw$ $17,000 = 200w$ $85 = w$ $17,000 \text{ square feet}/125 = 136 \text{ lights are needed for this job.}$	
3. An electrician has to ascend to the top of a concrete silo to change a light. The silo has a cubic feet of 15,000, with a radius of 10 feet. How high will the boom need to reach to safely get to the light?	$V = \pi r^2 h$ $15,000 = 3.14 \times 100 \times h$ $15,000 = 314 \times h$ $h = 15,000/314$ $h = 47.770 \text{ feet}$	A 50 foot minimum boom lift will be needed.
Problems	Related, Generic Math Concepts	Solutions
4. What is the radius of a cylinder, whose height is 3 inches and which holds 35 in. <sup>3</sup> of fluid?	$v = \pi r^2 h \rightarrow 35 = (3.14)r^2(3) \rightarrow 35 = 9.42r^2$ $\frac{35}{9.42} = \frac{9.42r^2}{9.42} \rightarrow 3.7155 = r^2 \rightarrow \sqrt{3.7155} = \sqrt{r^2}$ $1.93 \text{ in.} = r$	
5. A family would like to build a fence in their backyard to give their dog room to run. They will attach the fence to either side of the house (34 feet). How long should the fence extend to give the dog 300 ft. <sup>2</sup> of running room?	$A = lw$ $300 = l(34)$ $\frac{300}{34} = \frac{l(34)}{34}$ $8.82 \text{ ft.} = l$	
6. A family has 150 feet of fencing to fence in their garden. If their garden will have a length of 30 feet, how wide can they make it?	$P = 2l + 2w \rightarrow 150 = 2(30) + 2w \rightarrow 150 = 60 + 2w$ $150 - 60 = 60 - 60 + 2w \rightarrow 90 = 2w \rightarrow \frac{90}{2} = \frac{2w}{2} \rightarrow 45 \text{ ft.} = w$	
Problems	PA Core Math Look	Solutions
7. Find the radius of a circle whose circumference is 20 feet.	$C = 2\pi r$ $20 = 2(3.14)r$ $20 = 6.28r$ $\frac{20}{6.28} = \frac{6.28r}{6.28} \rightarrow 3.185 \text{ ft.} = r$	
8. Find the radius of a circle whose area is 45 in. <sup>2</sup> .	$A = \pi r^2$ $45 = 3.14r^2$ $\frac{45}{3.14} = \frac{3.14r^2}{3.14}$ $14.33 = r^2$ $\sqrt{14.33} = \sqrt{r^2} \rightarrow 3.79 \text{ in.} = r$	
9. Find the height of a cylinder whose volume is 300 ft. <sup>3</sup> and whose radius is 6 ft.	$V = \pi r^2 h$ $300 = (3.14)(6)^2 h$ $300 = (3.14)(36)h$ $300 = 113.04h$ $\frac{300}{113.04} = \frac{113.04h}{113.04} \rightarrow 2.65 \text{ ft.} = h$	