

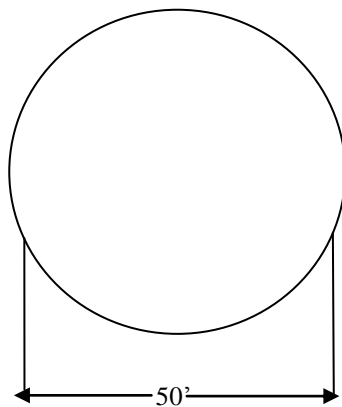
Determine roof rafter lengths = Verify and apply geometric theorems as they relate to geometric figures

Program Task: Determine roof rafter lengths.

Program Associated Vocabulary:
AREA, VOLUME, PERIMETER

Program Formulas and Procedures:

Example: A local fencing supply company is discontinuing a certain fence style and is selling it at a 70% discount. Unfortunately, they only have 150 feet of fencing left in their inventory. Your client asked for a corral that was 50 feet in diameter, but is very interested in taking advantage of this discounted fencing opportunity. Is there enough fencing to enclose the corral? If not, what is the largest diameter the corral can have? In this example, we will not include the gate that is needed to access the corral.



Solution:

Amount of fencing required to enclose the 50' diameter corral:

$$C = \pi d$$

$$C = 3.14 \times 50'$$

$$C = 157.07' \text{ (157-'1'')} \text{ (150 is not enough)}$$

Largest diameter possible when the circumference is 150:

$$C = \pi d$$

$$150 = 3.14d$$

$$\frac{150}{3.14} = d$$

$$d = 47.8 \text{ ft.}$$

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.

Opposite Operations	Addition & Subtraction
	Multiplication & Division
	Powers & Roots

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

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.

$$540 = l(6)(20)$$

$$540 = l(120)$$

$$\frac{540}{120} = \frac{l(120)}{120}$$

$$4.5 \text{ ft.} = \text{length}$$

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

Example 2: Find the radius of a cylinder whose height is 4 in. 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 using opposite operations.

$$62.8 = 12.56r^2$$

$$\frac{62.8}{12.56} = \frac{12.56r^2}{12.56}$$

$$5 = r^2$$

$$\sqrt{5} = \sqrt{r^2}$$

$$2.24 \text{ in.} = r$$

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

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

Instructor's Script - Comparing and Contrasting

Keep in mind that this PA Common Core Standard includes using formulas to calculate perimeter, area, surface area, and volume as well as using a formula to “work backwards” and find a missing dimension. Many students are able to calculate volumes but are unable to manipulate the formulas to find missing dimensions. Teaching these two concepts together will help the student to gain a deeper understanding of the concept of volume. In many real-life examples, students must also be able to convert the cubic linear measurement into gallons.

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.

$$P = 2l + 2w$$

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

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

CTE Instructor's Extended Discussion

Although with the advent of Computer Aided Drafting, these dimensions are easily obtained using the dimensioning software, hand drafting is still required under certain circumstances (for instance, a drafter may be on the job site and not have access to a computer). It is important that the student be able to perform these calculations.

Drafting & Design Technology/Technician (15.1301) T- Chart

Problems	Career and Technical Math Concepts	Solutions
1. Using the example problem from page one; calculate the fencing required if the corral has a 75' diameter.		
2. A rectangular container holds 1600 cubic feet. It is 10' high and 8' deep. Determine the length.		
3. Determine the length of a round tank that is 24" in diameter and must hold 80 gallons of water. (One gallon of water = .133 cu. ft.).		
Problems	Related, Generic Math Concepts	Solutions
4. What must the radius of a cylinder whose height is 3 inches be if the cylinder is to hold 35 in ³ 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 ² of running room?		
6. A family has 150 feet of fencing to fence in their rectangular 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 ² .		
9. Find the height of a cylinder whose volume is 300 ft ³ and whose radius is 6 ft.		

Drafting & Design Technology/Technician (15.1301) T- Chart

Problems	Career and Technical Math Concepts	Solutions
1. Using the example problem from page one; calculate the fencing required if the corral has a 75' diameter.	$C = 3.14 \times 75$ $C = 235.5'$	
2. A rectangular container holds 1600 cubic feet. It is 10' high and 8' deep. Determine the length.	$V = lwh$ $1600 = 1 \times 10 \times 8$ $1600 = 1 \times 80$ $1600/80 = 20'$	
3. Determine the length of a round tank that is 24" in diameter and must hold 80 gallons of water. (One gallon of water = .133 cu. ft.).	Volume = 80 gallons x .133 cu. ft. = 10.64 cu. ft. $V = \pi r^2 h$ $10.64 = 3.14 \times 1^2 \times h$ $10.64 = 3.14 \times 1 \times h$ $10.64 = 3.14h$ $10.64/3.14 = 3.39'$	
Problems	Related, Generic Math Concepts	Solutions
4. What must the radius of a cylinder whose height is 3 inches be if the cylinder is to hold 35 in ³ of fluid?	$v = \pi r^2 h$ $35 = (3.14)r^2(3)$ $35 = 9.42r^2$ $\frac{35}{9.42} = \frac{9.42r^2}{9.42}$ $3.7155 = r^2$ $\sqrt{3.7155} = \sqrt{r^2}$ 1.93in. = 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 ² of running room?	$A = lw$ $300 = l(34)$ $\frac{300}{34} = \frac{l(34)}{34}$ 8.82 ft. = l	
6. A family has 150 feet of fencing to fence in their rectangular garden. If their garden will have a length of 30 feet, how wide can they make it?	$P = 2l + 2w$ $150 = 2(30) + 2w$ $150 = 60 + 2w$ $150 - 60 = 60 - 60 + 2w$ $90 = 2w$ $\frac{90}{2} = \frac{2w}{2}$ 45 ft. = w	
Problems	PA Core Math Look	Solutions
7. Find the radius of a circle whose circumference is 20 feet.	$C = 2\pi r$ $20 = 2(3.14)r$ $20 = 6.28r$ $\frac{20}{6.28} = \frac{6.28r}{6.28}$ 3.185 ft. = r	
8. Find the radius of a circle whose area is 45 in ² .	$A = \pi r^2$ $45 = 3.14r^2$ $\frac{45}{3.14} = \frac{3.14r^2}{3.14}$ $14.33 = r^2$ $\sqrt{14.33} = \sqrt{r^2}$ 3.79 in. = r	
9. Find the height of a cylinder whose volume is 300 ft ³ and whose radius is 6 ft.	$V = \pi r^2 h$ $300 = (3.14)(6)^2 h$ $300 = (3.14)(36)h$ $300 = 113.04h$ $\frac{300}{113.04} = \frac{113.04h}{113.04}$ 2.65 ft. = h	