

Calculate the volume used in concrete formation =

Explain volume formulas and use them to solve problems

Program Task: Calculate the volume of concrete necessary to pour concrete Sonotube forms used to support various carpentry projects.

PA Core Standard: CC.2.3.HS.A.12

Program Associated Vocabulary:
DIMENSION, ESTIMATE, CUBIC VOLUME, DIAMETER, BOARD FEET (12"x12"x1") a UNIT OF VOLUME

Description: Explain volume formulas and use them to solve problems.

Math Associated Vocabulary:
LENGTH, VOLUME, DIAMETER, RADIUS, HEIGHT

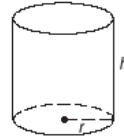
Program Formulas and Procedures:
Formula to find volume of a Sonotube

Cubic inches = 3.14 x radius (inches) x radius (inches) x height (inches)

Formulas and Procedures:

Volume:

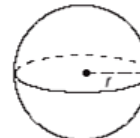
Cylinder:
 $V = \pi r^2 h$



Cone:
 $V = \frac{1}{3}\pi r^2 h$



Sphere:
 $V = \frac{4}{3}\pi r^3$



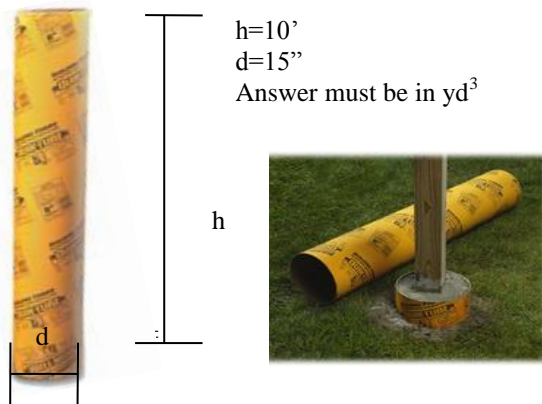
Pyramid:
 $V = \frac{1}{3}(\text{area of the base})h$
h = height b = base

ℓ = slant length or slant height



Example:

1 cubic foot contains 1728 cubic inches.
1 cubic yard contains 27 cubic feet.



radius (r) = diameter (d) ÷ 2 = 15 ÷ 2 = 7.5"
height = 10' = 10 x 12" = 120"

$$V = \pi r^2 h$$

$$V = \pi(7.5^2 \times 120)$$

$$V = \pi(56.25 \times 120)$$

$$V \approx 21,206 \text{ in}^3$$

$$V = 21,206 \div 1728$$

(There are 1,728 cu.in. in one cu.ft.)

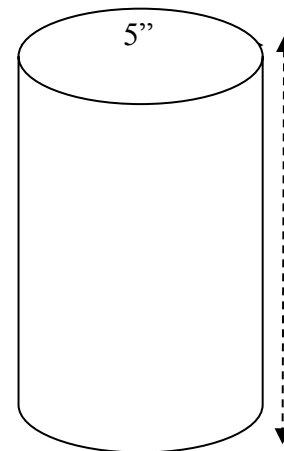
$$V \approx 12.3\text{ft}^3 \text{ (Round to } 13\text{ft}^3)$$

$$V = 13 \div 27$$

(There are 27cu.ft. in one cu.yd.)

$$V \approx .48\text{yd}^3 \text{ (Round to } .5\text{yd}^3)$$

Always remember to round up when you are working with materials regardless of the math concept of "5". Ex. 12.2 rounds to 12 1/2 or 13, because you will need "at least" 12.2 – not less. You also need to think about waste.



Example: Find the volume of the cylinder above.

Diameter = 5 inches, Height = 10 inches

Radius = 5 ÷ 2 = 2.5 inches

$$V = \pi r^2 h$$

$$V = \pi \times (2.5)^2 \times 10$$

$$V = \pi \times 6.25 \times 10$$

$$V = \pi \times 62.5$$

$$V \approx 196.3495 \text{ cu. in.}$$

Instructor's Script - Comparing and Contrasting

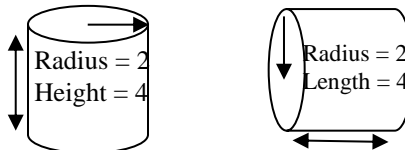
Whether calculating Sonotube volume or mathematical volume, the math concepts and the formulas used are very similar. Occasionally, carpentry texts describe volume formulas in terms of diameter (**d**) instead of radius (**r**). When this happens, π is often replaced with 0.7854 ($\pi/4$), since each diameter is 2 x the radius ($2 \times 2 = 4$).

Cylinder volume: $V = \pi r^2 h = .7854 \times \text{diameter} \times \text{diameter} \times \text{height}$

If the volume involves a circular or spherical shape (cylinder, sphere, cone), then π will be part of the calculation. The best way to use π in your calculations is to use a π key on the calculator, if available. Otherwise, using 3.14 as an approximation is fine.

The mathematical formulas for volume indicate a certain type of orientation that may not match the application in question. For example, h will designate height of a cylinder, but if the cylinder is horizontal, h will be the same as the length.

Both cylinders have same volume:



Common Mistakes Made By Students

Using incorrect formula: Correctly identify the type of object you are dealing with and use the appropriate formula. Two formulas may be needed for complex objects.

Most volume formulas need radius (r), NOT diameter (d): If you are given a diameter, halve it to get the radius before using the formula. For example if the diameter is 10 inches then the radius = $10 \div 2 = 5$ inches.

Using Consistent Units: If the problem asks for the answer in square feet instead of square inches, be sure to either convert your given measurements into feet first ($\text{inches} \div 12 = \text{feet}$) or convert your cubic inch answer into cubic feet ($\text{sq. inches} \div 1,728 = \text{cu. ft.}$)

1 cubic foot is a box 12 inches by 12 inches by 12 inches, so the calculation to convert cubic inches to cubic feet must use $12 \times 12 \times 12 = 1,728$ cu. in. per cu. ft.

1 cubic yard is a box 3 feet by 3 feet by 3 feet, so the conversion of cubic feet to cubic yards uses 27 cu. ft. per cu. yd.

CTE Instructor's Extended Discussion

Some of the Construction Carpentry topics that require an understanding of volume and the ability to calculate volume would include, but not be limited to:

1. Foundations
2. Block
3. Size of a shed, etc.

Carpentry (46.0201) T-Chart

Problems	Related, Generic Math Concepts	Solutions
1. A customer has asked you to construct an above ground, cylindrical rain water holding tank with $r = 12'$ and $h = 25'$. What will be the total volume of the water tank?		
2. You need to set 3 concrete piers to support an above ground deck. Each pier $d = 12''$ and $h = 60''$. Find the volume of one pier in in^3 , ft^3 & yd^3 ?		
3. You need to build three 4-sided pyramids to accent a retaining wall. Each side of the base (b) = $18''$, height (h) = $15''$. What is the volume of each pyramid? $V = \frac{1}{3}(\text{Area of base}) \times h$ (Area of base = b^2)		
Problems	Related, Generic Math Concepts	Solutions
4. Your car's engine is a "301." 301 means the engine displaces 301in.^3 . You find the bore (diameter) = $4''$ and the stroke (height or length) = $3''$. What is the Cubic Inch Displacement (volume) of one cylinder?		
5. One soup can has a diameter = $3''$ and height = $4''$; another soup can has a diameter = $4''$ and a height = $3''$. Which can holds more soup?		
6. A #7 regulation basketball has a $d = 9.39$. What is the volume of the basketball? $V = \frac{4}{3}\pi r^3$		
Problems	PA Core Math Look	Solutions
7. Find the volume of a cylinder, $d = 12.5'$ and $h = 28.45'$.		
8. Find the volume of a sphere, $d = 27.75''$.		
9. Find the volume of a pyramid with a square base with sides of $10''$ and a height of $25''$. $V = \frac{1}{3} Bh$ (pyramid, B = base area)		

Problems	Occupational (Contextual) Math Concepts	Solutions
1. A customer has asked you to construct an above ground, cylindrical rain water holding tank with $r = 12'$ and $h = 25'$. What will be the total volume of the water tank?	$V = \pi 12^2 25$ $V = \pi \times (144) \times 25$ or $V = 3.14 \times (12^2) \times 25$ $V \approx 11,310 \text{ft}^3$ (rounded from 11309.73355)	
2. You need to set 3 concrete piers to support an above ground deck. Each pier $r = 12''$ and $h = 60''$. Find the volume of one pier in in^3 , ft^3 & yd^3 ?	$V = \pi 12^2 60$ $V = \pi \times 144 \times 60$ $V \approx 27143.4 \text{in}^3$ $V = 27143.4 \div 1728$ $V \approx 15.7 \text{ft}^3$ $V = 16 \div 27 \approx .6 \text{yd}^3$ (Rounded from 0.59)	
3. You need to build three 4-sided pyramids to accent a retaining wall. Each side of the base (b) = $18''$, height (h) = $15''$. What is the volume of each pyramid in in^3 ?	$V = \frac{1}{3} (\text{Area of base}) \times h$ (Area of base = b^2) $V = \frac{1}{3} (18^2 \times 15)$ $V = \frac{1}{3} \times 4860$ $V = 1620 \text{in}^3$	
Problems	Related, Generic Math Concepts	Solutions
4. Your car's engine is a "301." 301 means the engine displaces 301in^3 . You find the bore (diameter) = $4''$ and the stroke (height or length) = $3''$. What is the Cubic Inch Displacement (volume) of one cylinder?	$\text{CID} = \pi 2^2 \times 3$ or $\frac{4^2 \pi 3}{4}$ or $\frac{d^2 \pi h}{4}$ $\text{CID} = \pi (4) \times 3$ or $16 \times \pi \times 3 \div 4$ or $\text{CID} = \pi \times 4 \times 3$ or 12.6×3 $\text{CID} \approx 37.7 \text{in}^3$	
5. One soup can has a diameter = $3''$ and height = $4''$; another soup can has a diameter = 4 and a height = 3 . Which can holds more soup?	$V = \pi r^2 h$ Can 1: $V = \pi (1.5)^2 4$ Can 2: $V = \pi (2)^2 3$ $V \approx 28.27 \text{in}^3$ $V \approx 37.70 \text{in}^3$	
6. A #7 regulation basketball has a $d = 9.39''$. What is the volume of the basketball?	$V = \frac{4}{3} \times \pi \times r^3 \longrightarrow V = 1.333 \times \pi \times 4.695^3$ $V = 1.333 \times \pi \times 103.5$ $V \approx 433.43 \text{in}^3$	
Problems	PA Core Math Look	Solutions
7. Find the volume of a cylinder, $d = 12.50'$ and $h = 28.75'$.	$V = \pi r^2 h$ $V = \pi \times 6.25^2 \times 28.75$ $V \approx 3526.367 \text{ft}^3$	
8. Find the volume of a sphere, $d = 27.75''$.	$V = \frac{4}{3} \times \pi \times r^3 \longrightarrow V = 1.333 \times \pi \times 13.875^3$ $V = 1.333 \times \pi \times 2,671.15$ $V \approx 11,186.09 \text{in}^3$	
9. Find the volume of a pyramid with a square base with sides of $10''$ and a height of $25''$.	$V = \frac{1}{3} (10^2 \times 25) \longrightarrow V = \frac{1}{3} \times 2500 \approx 833.33 \text{in}^3$	