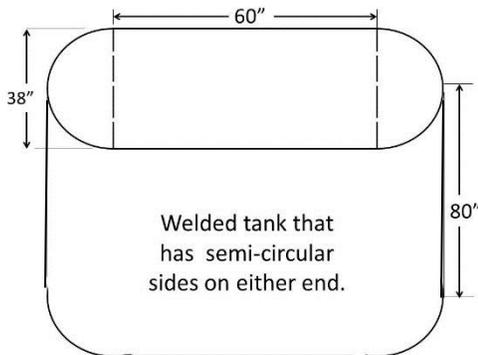| **Determine volume of welded object** =	**Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems**

Program Task: Welders are asked to weld many different types of containers in order to hold liquids and gases. Irrigation pipes, water tanks, and settling tanks are just a few of these projects. Welders should know the volume needed by the manufacturer if they are required to do the cutting and welding to construct the tanks.

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

Description: Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

Program Associated Vocabulary
GALLONS (CAPACITY), RADIUS, HEIGHT, DIAMETER, WIDTH, π=3.14, VOLUME

Math Associated Vocabulary
AREA, VOLUME, LENGTH, WIDTH, HEIGHT, RECTANGLE, ROUND, CYLINDRICAL, BASE, RADIUS, RECTANGULAR PRISM

Program Formulas and Procedures

60"
38"
80"

Welded tank that has semi-circular sides on either end.

Formulas and Procedures for Volume:

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

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

Rectangular Prism:
$V = lwh$

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

Example 1: A welder must create a welded tank with a capacity of at least 1,000 gallons, but not more than 1,200 gallons, for a dairy farmer. The drawn dimensions that the welder received are shown above. Will these meet the farmer's specifications? Should the welder cut the parts?

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

r = radius   h = height   w = width
b = base   l = length or slant height

Step 1: What shapes do we have? We have two half cylinders (1 whole) and a whole rectangular prism.

Step 2: What formulas do we need?

$V = \pi r^2 h$ Volume of a cylinder

$V = lwh$ Volume of a rectangular prism

Step 3: Identify what you are given in the problem.
Diameter of Circle = 38"   Radius (r) = ½ (D) = 19"
Height of container (h)= 80"
Width of container (w) = 38" (same as cylinder diameter)
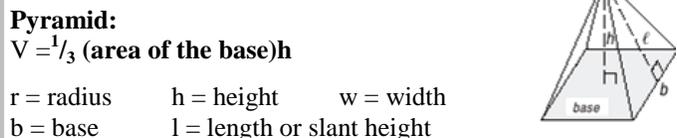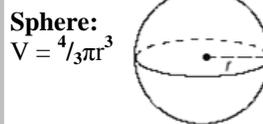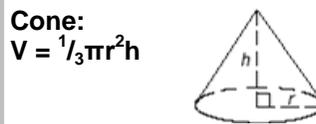Length of container (l) = 60"
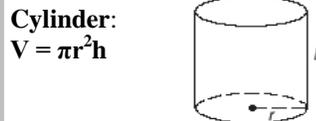
Step 4: Substitute and solve.

$V = \pi r^2 h$ $V = \pi(19)^2 80 = 90{,}683.20 \text{ in}^3$

$V = lwh$ $V = (60)(38)(80) = 182{,}400.00 \text{ in}^3$

Add: $90{,}683.20 + 182{,}400.00 = 273{,}083.20 \text{ in}^3$

$1 \text{ gallon} = 231 \text{ in}^3$

$\dfrac{273{,}083.20 \text{ in}^3}{1} \text{ x } \dfrac{1 \text{ gallon}}{231 \text{ in}^3} = 1{,}182.18 \text{ gallons}$

Yes-It will work.   1,000g<1,182.18g<1,200g

Example: How many cubic inches of air can a beach ball hold if it has a diameter of 14 inches?

Steps to finding volume
1. Identify the solid (sphere)
2. Write the formula for calculating the volume of that solid using the formula sheet
   $V = \frac{4}{3}\pi r^3$
3. Identify the properties of the solid used in the formula
   diameter = 2 x radius or Radius= ½(Diameter)
   $r = \frac{1}{2} \text{ x } 14 = 7$
4. Substitute the actual properties of the solid into the formula
   $V = \frac{4}{3}\pi r^3$
5. Perform the necessary mathematical operations to obtain your answer
   $V = \frac{4}{3}\pi r^3 = \frac{4}{3}(3.14)(7^3) \approx 1436$
6. Write the appropriate unit after your answer.
   1436 in^3

Teacher's Script - Comparing and Contrasting

This is a great example of a real life application using volume formulas. It is very important for students to know which volume formula to use and to draw pictures so they know what information they are given.

In a PA Core Standard type problem, students may be required to leave the answer in cubic inches. The conversion is the next step in the solution.

Students also should remember to convert the diameter to radius by dividing it in ½ or dividing by 2. These problems all use radius, not diameter.

The other math concept, which helps students, is that π is always present in a circle formula.

**** In this T-Chart, pi was represented by the number 3.14. If students use the pi key in the calculator, the answers may be different. Actually, the calculator gives you a more accurate answer.

Common Mistakes Made By Students

Using Incorrect Formula: Correctly identify the type of object and use the appropriate formula (2 formulas may be needed for complex objects).

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 (inches ÷ 12 = feet) OR convert your square inch answer into square feet (sq. inches ÷ 144 = sq. feet).
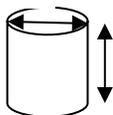
Lab Teacher's Extended Discussion

It is so important to have students connect the welding curriculum to the math in their classroom. Even though the students just want to weld, they will be asked to design items that require them to cut and read drawings from other individuals. Students have a tendency to "take the word" of someone and not double check or use common sense to determine if the measurements are correct. "Double checking" needs to be taught over and over again.

For example, a dairy farmer wanted a tank for milk with a specific diameter. A student solved this problem using the diameter instead of the radius. He got a very large volume. He did not think about it and wrote it down. A good idea is to have the student draw a picture. After the student drew the picture, he realized his mistake. Had he ordered supplies based on his original measurements, he would have spent a lot of extra money to build a tank that was too large. Maybe he would have been fired.

Welding & Metal Manufacturing (48.0508) T-Chart

	Problems	Occupational (Contextual) Math Concepts	Solutions
1.	A welder will cut and weld an outside storage cylinder with a height of 4.8 ft. and a diameter of 2.2 ft. What is the volume of this item when he has it cut and welded? (Draw a picture.)		
2.	The welding supervisor asks you to weld a giant basketball for the top of Reading High's light. He wants it to have a diameter of 20 ft. What is the volume?		
3.	A tractor trailer needs a rectangular prism for behind the cab to carry chocolate bars. The maximum length he can have is 40 ft. and the maximum width is 8 ft. If the capacity (volume) is 4,320 ft^3, what is the height of the trailer?		
	Problems	Related, Generic Math Concepts	Solutions
4.	One soup can has a diameter of 3" and a height of 4"; another soup can has a diameter of 4" and a height of 3". Which can holds more soup?		
5.	A size 7 regulation basketball has a diameter of 9.39". What is the volume of the basketball?		
6.	How much water would you need to fill a rectangular fish tank with a height of 16.5 inches, a length of 32 inches, and a width of 8.5 inches?		
	Problems	PA Core Math Look	Solutions
7.	Find the volume of a cylinder, d=12.5' h=28.45'		
8.	Find the volume of a sphere, d=27.75"		
9.	Find the volume of 4-sided pyramid with a square base b=10, h=25		

Problems	Occupational (Contextual) Math Concepts	Solutions
1. A welder will cut and weld an outside storage cylinder with a height of 4.8 ft. and a diameter of 2.2 ft. What is the volume of this item when he has it cut and welded? (Draw a picture.)	Volume of a cylinder $= \pi r^2 h$ $V = \pi (1.1\text{ft})^2 (4.8\text{ft}) = 18.24 \text{ ft}^3$	2.2 ft.
2. The welding supervisor asks you to weld a giant basketball for the top of Reading High's light. He wants it to have a diameter of 20 ft. What is the volume?	Radius $= \dfrac{\text{Diameter}}{2} = \dfrac{20}{2} = 10\text{ft}$ Volume of a sphere $= \dfrac{4}{3} \pi r^3 \rightarrow V = \dfrac{4}{3} \pi 10^3 \rightarrow V = 4{,}186.66 \text{ ft}^3$	
3. A tractor trailer needs a rectangular prism for behind the cab to carry chocolate bars. The maximum length he can have is 40 ft. and the maximum width is 8 ft. If the capacity (volume) is 4,320 ft³, what is the height of the trailer?	Volume of a rectangular prism $= lwh$ We know: $l = 40$ ft $w = 8$ ft. Volume $= 4{,}320 \text{ ft}^3$ Find: Height(h) $V = lwh$ $4{,}320 = (40)(8)h$ $4320 = 320h$ $\dfrac{4320}{320} = \dfrac{320h}{320}$ $13.5 \text{ ft} = h$ Height $= 13.5$ ft or 13 ft 6"	

Problems	Related, Generic Math Concepts	Solutions
4. One soup can has a diameter of 3" and a height of 4"; another soup can has a diameter of 4" and a height of 3". Which can holds more soup?	$V = \pi r^2 h$ Can 1: $V = \pi (1.5)^2 4$ Can 2: $V = \pi (2)^2 3$ $V = 28.26 \text{in}.^3$ $V = 37.68 \text{in}.^3$	
5. A size 7 regulation basketball has a diameter of 9.39". What is the volume of this basketball?	$V = \dfrac{4}{3} \times \pi \times r^3 \longrightarrow V = 1.333 \times \pi \times 4.695^3$ $V = 1.333 \times \pi \times 103.5$ $V = 433.43 \text{in}^3$	
6. How much water would you need to fill a rectangular fish tank with a height of 16.5 inches, a length of 32 inches, and a width of 8.5 inches?	Volume $= (32)(8.5)(16.5) = 4{,}488 \text{ in}^3$	

Problems	PA Core Math Look	Solutions
7. Find the volume of a cylinder, d=12.5' h=28.75'	$V = \pi r^2 h$ $V = \pi \times 6.25^2 \times 28.75$ $V = 3526.37 \text{ft}^3$	
8. Find the volume of a sphere, d=27.75"	$V = \dfrac{4}{3} \times \pi \times r^3 \longrightarrow V = 1.333 \times \pi \times 13.875^3$ $V = 1.333 \times \pi \times 2{,}671.15$ $V = 11{,}180.42 \text{in}^3$	
9. Find the volume of 4-sided pyramid with a square base side=10 and a height =25.	$V = \dfrac{1}{3}(\text{area of base})h$ $V = \dfrac{1}{3}(10)(10)(25) \approx 833.33 \text{unit}^3$	