

13.1 Volume of Cylinders



FL 8.G.3.9

Know the formulas for the volumes of...cylinders...and use them to solve real-world and mathematical problems.



ESSENTIAL QUESTION

How do you find the volume of a cylinder?

EXPLORE ACTIVITY



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Modeling the Volume of a Cylinder

A **cylinder** is a three-dimensional figure that has two congruent circular bases that lie in parallel planes. The volume of any three-dimensional figure is the number of cubic units needed to fill the space taken up by the solid figure.

One cube represents one cubic unit of volume. You can develop the formula for the volume of a cylinder using an empty soup can or other cylindrical container. First, remove one of the bases.

- A** Arrange centimeter cubes in a single layer at the bottom of the cylinder. Fit as many cubes into the layer as possible. How many cubes are in this layer?

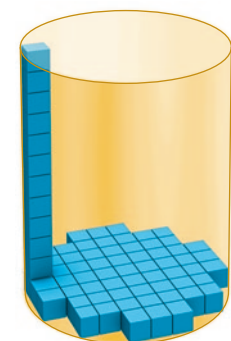
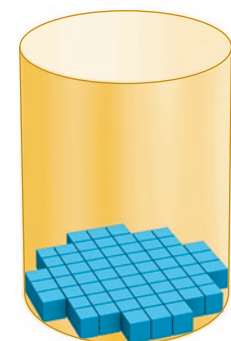
- B** To find how many layers of cubes fit in the cylinder, make a stack of cubes along the inside of the cylinder. How many layers fit in the cylinder?

- C** How can you use what you know to find the approximate number of cubes that would fit in the cylinder?

Reflect

1. **Make a Conjecture** Suppose you know the area of the base of a cylinder and the height of the cylinder. How can you find the cylinder's volume?

2. Let the area of the base of a cylinder be B and the height of the cylinder be h . Write a formula for the cylinder's volume V . _____





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Finding the Volume of a Cylinder Using a Formula

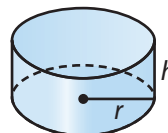
Finding volumes of cylinders is similar to finding volumes of prisms. You find the volume V of both a prism and a cylinder by multiplying the height h by the area of the base B , so $V = Bh$.

The base of a cylinder is a circle, so for a cylinder, $B = \pi r^2$.

Volume of a Cylinder

The volume V of a cylinder with radius r is the area of the base B times the height h .

$$V = Bh \text{ or } V = \pi r^2 h$$



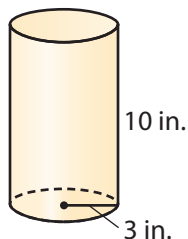
EXAMPLE 1



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Find the volume of each cylinder. Round your answers to the nearest tenth if necessary. Use 3.14 for π .

A



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

$$\approx 3.14 \cdot 3^2 \cdot 10$$

Substitute.

$$\approx 3.14 \cdot 9 \cdot 10$$

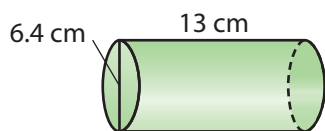
Simplify.

$$\approx 282.6$$

Multiply.

The volume is about 282.6 in^3 .

B



Since the diameter is 6.4 cm, the radius is 3.2 cm.

Recall that the diameter of a circle is twice the radius, so $2r = d$ and $r = \frac{d}{2}$.

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

$$\approx 3.14 \cdot 3.2^2 \cdot 13$$

Substitute.

$$\approx 3.14 \cdot 10.24 \cdot 13$$

Simplify.

$$\approx 418$$

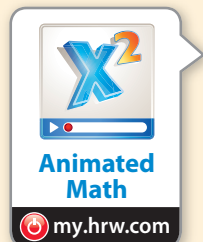
Multiply.

The volume is about 418 cm^3 .

Reflect

3. **What If?** If you want a formula for the volume of a cylinder that involves the diameter d instead of the radius r , how can you rewrite it?

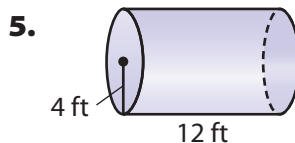
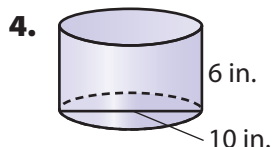
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YOUR TURN

Find the volume of each cylinder. Round your answers to the nearest tenth if necessary. Use 3.14 for π .



Finding the Volume of a Cylinder in a Real-World Context

The Longhorn Band at the University of Texas at Austin has one of the world's largest bass drums, known as Big Bertha.

EXAMPLE 2



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Big Bertha has a diameter of 8 feet and is 4.5 feet deep. Find the volume of the drum to the nearest tenth. Use 3.14 for π .

STEP 1 Find the radius of the drum.

$$r = \frac{d}{2} = \frac{8}{2} = 4 \text{ ft}$$

STEP 2 Find the volume of the drum.

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

$$\approx 3.14 \cdot 4^2 \cdot 4.5 \quad \text{Substitute.}$$

$$\approx 3.14 \cdot 16 \cdot 4.5 \quad \text{Simplify the exponent.}$$

$$\approx 226.08 \quad \text{Multiply.}$$

○ The volume of the drum is about 226.1 ft^3 .



YOUR TURN

6. A drum company advertises a snare drum that is 4 inches high and 12 inches in diameter. Find the volume of the drum to the nearest tenth. Use 3.14 for π .



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Guided Practice

1. **Vocabulary** Describe the bases of a cylinder. (Explore Activity)

2. Figure 1 shows a view from above of inch cubes on the bottom of a cylinder. Figure 2 shows the highest stack of cubes that will fit inside the cylinder. Estimate the volume of the cylinder. Explain your reasoning. (Explore Activity)

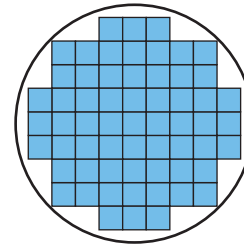


Figure 1



Figure 2

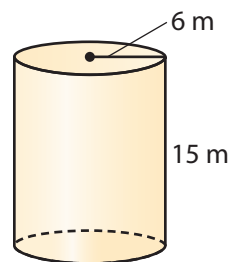
3. Find the volume of the cylinder to the nearest tenth. Use 3.14 for π . (Example 1)

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

$$V = \pi \cdot \boxed{}^2 \cdot \boxed{}$$

$$\approx 3.14 \cdot \boxed{} \cdot \boxed{}$$

$$\approx \boxed{}$$



The volume of the cylinder is approximately _____ m^3 .

4. A Japanese odaiko is a very large drum that is made by hollowing out a section of a tree trunk. A museum in Takayama City has three odaikos of similar size carved from a single tree trunk. The largest measures about 2.7 meters in both diameter and length, and weighs about 4.5 metric tons. Using the volume formula for a cylinder, approximate the volume of the drum to the nearest tenth. (Example 2)

The radius of the drum is about _____ m.

The volume of the drum is about _____ m^3 .



ESSENTIAL QUESTION CHECK-IN

5. How do you find the volume of a cylinder? Describe which measurements of a cylinder you need to know.

13.1 Independent Practice



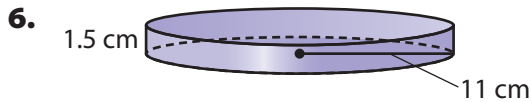
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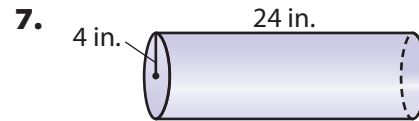


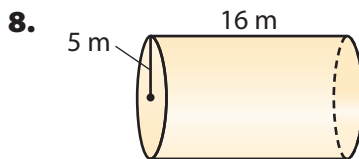
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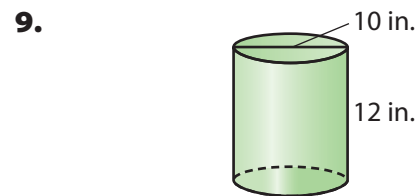
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Find the volume of each figure. Round your answers to the nearest tenth if necessary. Use 3.14 for π .









- 10.** A cylinder has a radius of 4 centimeters and a height of 40 centimeters.

- 11.** A cylinder has a radius of 8 meters and a height of 4 meters.

Round your answer to the nearest tenth, if necessary. Use 3.14 for π .

- 12.** The cylindrical Giant Ocean Tank at the New England Aquarium in Boston is 24 feet deep and has a radius of 18.8 feet. Find the volume of the tank.

- 13.** A standard-size bass drum has a diameter of 22 inches and is 18 inches deep. Find the volume of this drum.

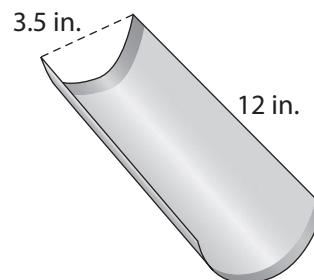
- 14.** Grain is stored in cylindrical structures called silos. Find the volume of a silo with a diameter of 11.1 feet and a height of 20 feet.

- 15.** The Frank Erwin Center, or “The Drum,” at the University of Texas in Austin can be approximated by a cylinder that is 120 meters in diameter and 30 meters in height. Find its volume.



- 16.** A barrel of crude oil contains about 5.61 cubic feet of oil. How many barrels of oil are contained in 1 mile (5280 feet) of a pipeline that has an inside diameter of 6 inches and is completely filled with oil? How much is "1 mile" of oil in this pipeline worth at a price of \$100 per barrel?

- 17.** A pan for baking French bread is shaped like half a cylinder. It is 12 inches long and 3.5 inches in diameter. What is the volume of uncooked dough that would fill this pan?



FOCUS ON HIGHER ORDER THINKING

- 18. Explain the Error** A student said the volume of a cylinder with a 3-inch diameter is two times the volume of a cylinder with the same height and a 1.5-inch radius. What is the error?

- 19. Communicate Mathematical Ideas** Explain how you can find the height of a cylinder if you know the diameter and the volume. Include an example with your explanation.

- 20. Analyze Relationships** Cylinder A has a radius of 6 centimeters. Cylinder B has the same height and a radius half as long as cylinder A. What fraction of the volume of cylinder A is the volume of cylinder B? Explain.

Work Area