Volume

COMMON CORE

ESSENTIAL QUESTION

How can you use volume to solve real-world problems?
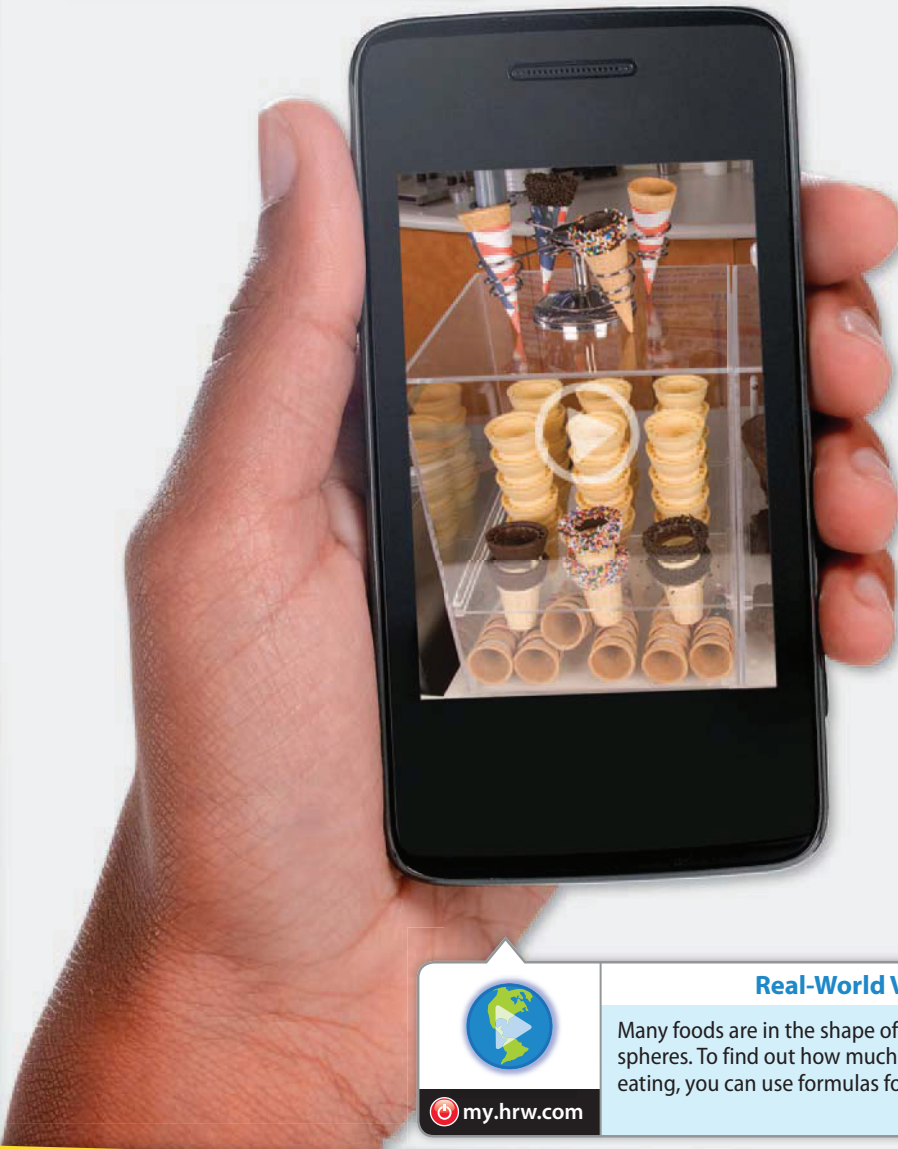
Real-World Video

Many foods are in the shape of cylinders, cones, and spheres. To find out how much of the food you are eating, you can use formulas for volume.

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Are YOU Ready?

Complete these exercises to review skills you will need for this module.

Exponents

EXAMPLE $6^3 = 6 \times 6 \times 6$ Multiply the base (6) by itself the number of times indicated by the exponent (3).

$= 36 \times 6$ Find the product of the first two terms.

$= 216$ Find the product of all the terms.

Evaluate each exponential expression.

1. 11^2 _____

2. 2^5 _____

3. $\left(\frac{1}{5}\right)^3$ _____

4. $(0.3)^2$ _____

5. 2.1^3 _____

6. 0.1^3 _____

7. $\left(\frac{9.6}{3}\right)^2$ _____

8. 100^3 _____

Round Decimals

EXAMPLE   Round 43.2685 to the underlined place.   The digit to be rounded: 6
The digit to its right is 8.
8 is *5 or greater*, so round *up*.

$43.2685 \longrightarrow 43.27$ The rounded number is 43.27.

Round to the underlined place.

9. 2.374 _____

10. 126.399 _____

11. 13.9577 _____

12. 42.690 _____

13. 134.95 _____

14. 2.0486 _____

15. 63.6352 _____

16. 98.9499 _____

Simplify Numerical Expressions

EXAMPLE $\frac{1}{3}(3.14)(4)^2(3) = \frac{1}{3}(3.14)(16)(3)$ Simplify the exponent.

$= 50.24$ Multiply from left to right.

Simplify each expression.

17. $3.14(5)^2(10)$ _____

18. $\frac{1}{3}(3.14)(3)^2(5)$ _____

19. $\frac{4}{3}(3.14)(3)^3$ _____

20. $\frac{4}{3}(3.14)(6)^3$ _____

21. $3.14(4)^2(9)$ _____

22. $\frac{1}{3}(3.14)(9)^2\left(\frac{2}{3}\right)$ _____

Reading Start-Up

Visualize Vocabulary

Use the ✔ words to complete the empty columns in the chart. You may use words more than once.

Shape	Distance Around	Attributes	Associated Review Words
circle		*r, d*	
square		90° corner, sides	
rectangle		90° corner, sides	

Understand Vocabulary

Complete the sentences using the preview words.

1. A three-dimensional figure that has one vertex and one circular base is a _____.

2. A three-dimensional figure with all points the same distance from the center is a _____.

3. A three-dimensional figure that has two congruent circular bases is a _____.

Active Reading

Three-Panel Flip Chart Before beginning the module, create a three-panel flip chart to help you organize what you learn. Label each flap with one of the lesson titles from this module. As you study each lesson, write important ideas like vocabulary, properties, and formulas under the appropriate flap.

Unpacking the Standards

Understanding the standards and the vocabulary terms in the standards will help you know exactly what you are expected to learn in this module.

COMMON CORE 8.G.9

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

Key Vocabulary

volume *(volumen)*
The number of cubic units needed to fill a given space.

cylinder *(cilindro)*
A three-dimensional figure with two parallel, congruent circular bases connected by a curved lateral surface.

What It Means to You

You will learn the formula for the volume of a cylinder.

UNPACKING EXAMPLE 8.G.9

The Asano Taiko Company of Japan built the world's largest drum in 2000. The drum's diameter is 4.8 meters, and its height is 4.95 meters. Estimate the volume of the drum.

$d = 4.8 \approx 5$

$h = 4.95 \approx 5$

$r = \frac{d}{2} \approx \frac{5}{2} = 2.5$

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

$\approx (3)\,(2.5)^2 \cdot 5$ *Use 3 for π.*

$= (3)\,(6.25)\,(5)$

$= 18.75 \cdot 5$

$= 93.75 \approx 94$

The volume of the drum is approximately 94 m³.

COMMON CORE 8.G.9

Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.
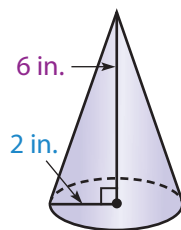
Key Vocabulary

cone *(cono)*
A three-dimensional figure with one vertex and one circular base.

sphere *(esfera)*
A three-dimensional figure with all points the same distance from the center.

What It Means to You

You will learn formulas for the volume of a cone and a sphere.

UNPACKING EXAMPLE 8.G.9

6 in.

2 in.

Find the volume of the cone. Use 3.14 for π.

$B = \pi(2^2) = 4\pi$ in²

$V = \frac{1}{3} \cdot 4\pi \cdot 6$ $V = \frac{1}{3}Bh$

$V = 8\pi$ *Use 3.14 for π.*

≈ 25.1 in³

The volume of the cone is approximately 25.1 in³.

The volume of a sphere with the same radius is
$V = \frac{4}{3}\pi r^3 \approx \frac{4}{3}(3)(2)^3 = 32$ in³.

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LESSON
13.1 Volume of Cylinders

COMMON CORE 8.G.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   COMMON CORE 8.G.9

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?
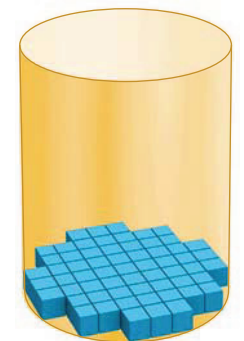
_____

_____

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*. _____

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

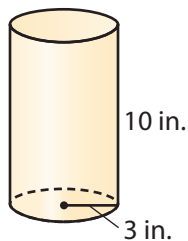| The volume V of a cylinder with radius r is the area of the base B times the height h.	
$V = Bh$ or $V = \pi r^2 h$	
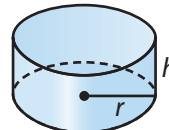
EXAMPLE 1

8.G.9

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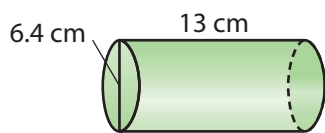
A

10 in.

3 in.

$V = \pi r^2 h$

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

$\approx 3.14 \cdot 9 \cdot 10$ Simplify.

≈ 282.6 Multiply.

The volume is about 282.6 in³.

B   6.4 cm   13 cm

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 $r = \frac{d}{2}$.
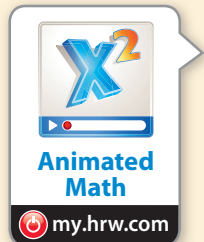
$V = \pi r^2 h$

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

$\approx 3.14 \cdot 10.24 \cdot 13$ Simplify.

≈ 418 Multiply.

The volume is about 418 cm³.

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?
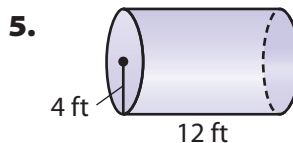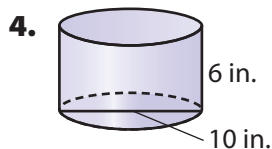
_____

My Notes

YOUR TURN

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

4.

6 in.

10 in.

_____

5.

4 ft

12 ft

_____

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 _Real World_   COMMON CORE 8.G.9

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.

$$V = \pi r^2 h$$
$$\approx 3.14 \cdot 4^2 \cdot 4.5 \qquad \text{Substitute.}$$
$$\approx 3.14 \cdot 16 \cdot 4.5 \qquad \text{Simplify the exponent.}$$
$$\approx 226.08 \qquad \text{Multiply.}$$

The volume of the drum is about 226.1 ft³.

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.

_____

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)
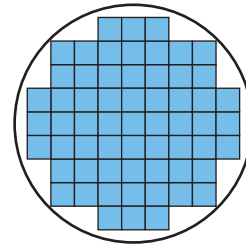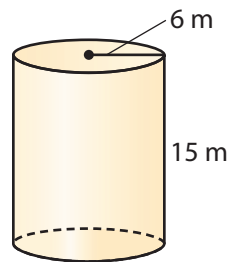
_____

_____

_____

Figure 1   Figure 2

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

$V = \pi r^2 h$

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

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

$\approx \boxed{}$

6 m

15 m

The volume of the cylinder is approximately _____ m³.

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 _____ m³.

? 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

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

6.

1.5 cm

11 cm

_____

7.

24 in.

4 in.

_____

8.

16 m

5 m

_____

9.

10 in.

12 in.

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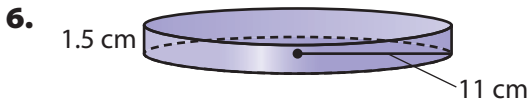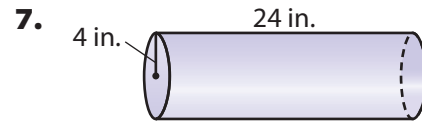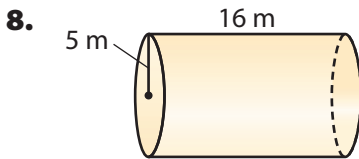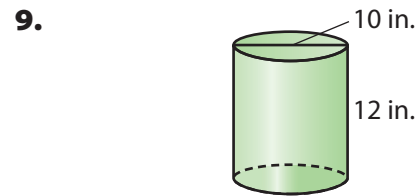
10. A cylinder has a radius of 4 centimeters and a height of 40 centimeters.

_____

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.

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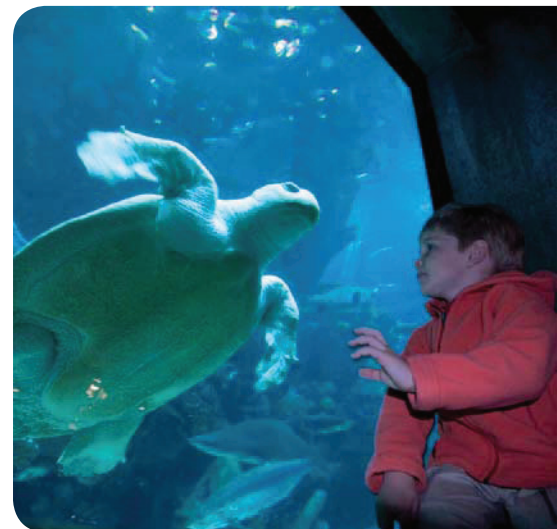
16. A barrel of crude oil contains about 5.61 cubic feet of oil. How many barrels of oil are contained in 1 mile (5280 feet) of a pipeline that has an inside diameter of 6 inches and is completely filled with oil? How much is "1 mile" of oil in this pipeline worth at a price of $100 per barrel?

_____

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?

3.5 in.

12 in.

_____
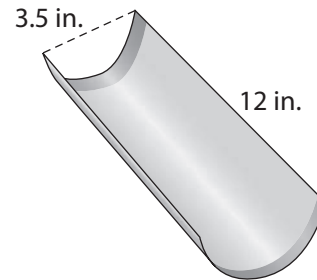
H.O.T. **FOCUS ON HIGHER ORDER THINKING**

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

LESSON
13.2 Volume of Cones

COMMON CORE 8.G.9

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

**? ESSENTIAL QUESTION**

How do you find the volume of a cone?

EXPLORE ACTIVITY
COMMON CORE 8.G.9

Modeling the Volume of a Cone

A **cone** is a three-dimensional figure that has one vertex and one circular base.

To explore the volume of a cone, Sandi does an experiment with a cone and a cylinder that have congruent bases and heights. She fills the cone with popcorn kernels and then pours the kernels into the cylinder. She repeats this until the cylinder is full.
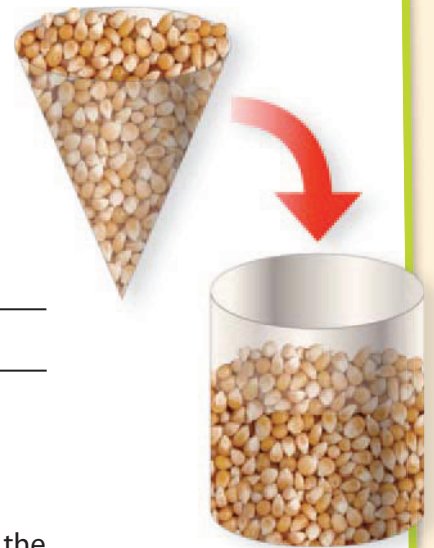
Sandi finds that it takes 3 cones to fill the volume of the cylinder.

STEP 1 What is the formula for the volume V of a cylinder with base area B and height h? _____

STEP 2 What is the area of the base of the cone? _____

STEP 3 Sandi found that, when the bases and height are the same,

_____ times $V_{cone} = V_{cylinder}$.

STEP 4 How does the volume of the cone compare to the volume of the cylinder?

Volume of the cone: $V_{cone} = \dfrac{\square}{\square} \cdot V_{cylinder}$

Reflect

1. Use the conclusion from this experiment to write a formula for the volume of a cone in terms of the height and the radius. Explain.

   _____

2. How do you think the formula for the volume of a cone is similar to the formula for the volume of a pyramid?

   _____

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Finding the Volume of a Cone Using a Formula

The formulas for the volume of a prism and the volume of a cylinder are the same: multiply the height h by the area of the base B, so $V = Bh$.

In the **Explore Activity**, you saw that the volume of a cone is one third the volume of a cylinder with the same base and height.

Volume of a Cone

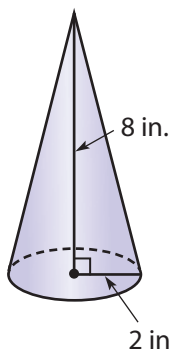|	
The volume V of a cone with radius r is one third the area of the base B times the height h. $$V = \frac{1}{3}Bh \text{ or } V = \frac{1}{3}\pi r^2 h$$	
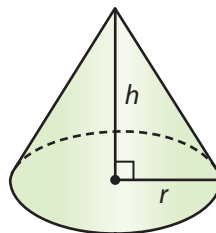
EXAMPLE 1

COMMON CORE 8.G.9

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

A

8 in.

2 in.

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

$\approx \frac{1}{3} \cdot \mathbf{3.14} \cdot \mathbf{2^2} \cdot \mathbf{8}$ Substitute.

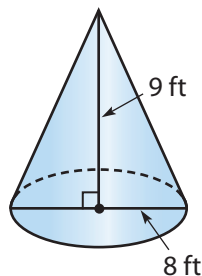$\approx \frac{1}{3} \cdot 3.14 \cdot \mathbf{4} \cdot 8$ Simplify.

$\approx \mathbf{33.5}$ Multiply.

The volume is about 33.5 in³.

B Since the diameter is 8 ft, the radius is 4 ft.

9 ft

8 ft

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

$\approx \frac{1}{3} \cdot \mathbf{3.14} \cdot \mathbf{4^2} \cdot \mathbf{9}$ Substitute.

$\approx \frac{1}{3} \cdot 3.14 \cdot \mathbf{16} \cdot 9$ Simplify.
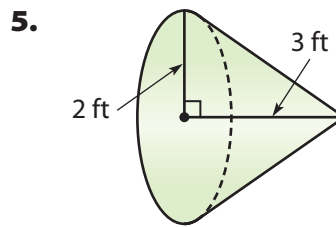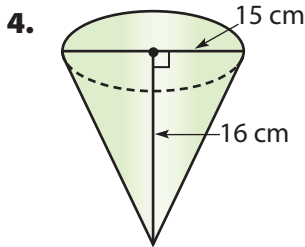
$\approx \mathbf{150.7}$ Multiply.

The volume is about 150.7 ft³.

Reflect

3. How can you rewrite the formula for the volume of a cone using the diameter d instead of the radius r? _____

YOUR TURN

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

4.
15 cm

16 cm

_____

5.
3 ft

2 ft

_____

Finding the Volume of a Volcano

The mountain created by a volcano is often cone–shaped.

EXAMPLE 2 Real World

Math On the Spot
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For her geography project, Karen built a clay model of a volcano in the shape of a cone. Her model has a diameter of 12 inches and a height of 8 inches. Find the volume of clay in her model to the nearest tenth. Use 3.14 for π.

STEP 1 Find the radius.

$$r = \frac{12}{2} = 6 \text{ in.}$$

STEP 2 Find the volume of clay.

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

$$\approx \frac{1}{3} \cdot 3.14 \cdot 6^2 \cdot 8 \qquad \text{Substitute.}$$

$$\approx \frac{1}{3} \cdot 3.14 \cdot 36 \cdot 8 \qquad \text{Simplify.}$$

$$\approx 301.44 \qquad \text{Multiply.}$$

The volume of the clay is about 301.4 in³.

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YOUR TURN

6. The cone of the volcano Parícutin in Mexico had a height of 410 meters and a diameter of 424 meters. Approximate the volume of the cone.

_____

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Guided Practice

1. The area of the base of a cylinder is 45 square inches and its height is 10 inches. A cone has the same area for its base and the same height. What is the volume of the cone? **(Explore Activity)**

$V_{cylinder} = Bh = \boxed{} \cdot \boxed{} = \boxed{}$

$V_{cone} = \frac{1}{3} V_{cylinder}$

$= \frac{1}{3} \boxed{}$

$= \boxed{}$

The volume of the cone is _____ in³.

2. A cone and a cylinder have congruent height and bases. The volume of the cone is 18 m³. What is the volume of the cylinder? Explain. **(Explore Activity)**
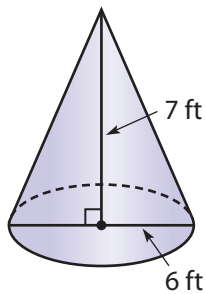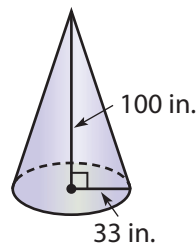
_____

_____

_____

_____

_____

Find the volume of each cone. Round your answer to the nearest tenth if necessary. Use 3.14 for π. (Example 1)

3.

7 ft

6 ft

_____

4.

100 in.

33 in.

_____

5. Gretchen made a paper cone to hold a gift for a friend. The paper cone was 15 inches high and had a radius of 3 inches. Find the volume of the paper cone to the nearest tenth. Use 3.14 for π. **(Example 2)**

_____

6. A cone-shaped building is commonly used to store sand. What would be the volume of a cone-shaped building with a diameter of 50 meters and a height of 20 meters? Round your answer to the nearest tenth. Use 3.14 for π. **(Example 2)**

_____

❓ ESSENTIAL QUESTION CHECK-IN

7. How do you find the volume of a cone?

_____

_____

_____

13.2 Independent Practice

COMMON CORE 8.G.9

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

8.

7 mm

8 mm

9.

6 in.

2 in.
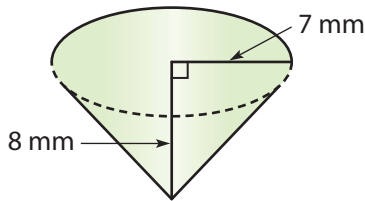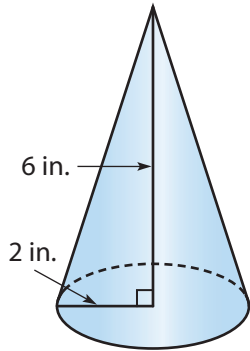
10. A cone has a diameter of 6 centimeters and a height of 11.5 centimeters.

_____

11. A cone has a radius of 3 meters and a height of 10 meters.

_____

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

12. Antonio is making mini waffle cones. Each waffle cone is 3 inches high and has a radius of $\frac{3}{4}$ inch. What is the volume of a waffle cone?

_____

13. A snack bar sells popcorn in cone-shaped containers. One container has a diameter of 8 inches and a height of 10 inches. How many cubic inches of popcorn does the container hold?

_____

14. A volcanic cone has a diameter of 300 meters and a height of 150 meters. What is the volume of the cone?

_____

15. **Multistep** Orange traffic cones come in a variety of sizes. Approximate the volume, in cubic inches, of a traffic cone that has a height of 2 feet and a diameter of 10 inches. Use 3.14 for π.

_____

Find the missing measure for each cone. Round your answers to the nearest tenth if necessary. Use 3.14 for π.

16. radius = _____

height = 6 in.

volume = 100.48 in³

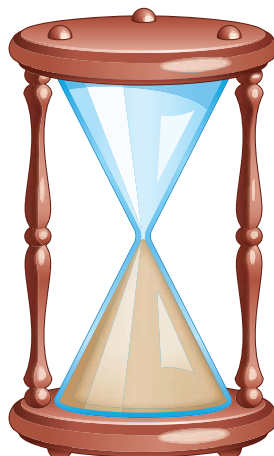**17.** diameter = 6 cm

height = _____

volume = 56.52 cm³

18. The diameter of a cone-shaped container is 4 inches, and its height is 6 inches. How much greater is the volume of a cylinder-shaped container with the same diameter and height? Round your answer to the nearest hundredth. Use 3.14 for π.

_____

19. Alex wants to know the volume of sand in an hourglass. When all the sand is in the bottom, he stands a ruler up beside the hourglass and estimates the height of the cone of sand.

    a. What else does he need to measure to find the volume of sand?

        _____

        _____

    b. **Make a Conjecture** If the volume of sand is increasing at a constant rate, is the height increasing at a constant rate? Explain.

        _____

        _____

        _____

20. **Problem Solving** The diameter of a cone is x cm, the height is 18 cm, and the volume is 301.44 cm³. What is x? Use 3.14 for π.

_____

21. **Analyze Relationships** A cone has a radius of 1 foot and a height of 2 feet. How many cones of liquid would it take to fill a cylinder with a diameter of 2 feet and a height of 2 feet? Explain.

_____

_____

_____

22. **Critique Reasoning** Herb knows that the volume of a cone is one third that of a cylinder with the same base and height. He reasons that a cone with the same height as a given cylinder but 3 times the radius should therefore have the same volume as the cylinder, since $\frac{1}{3} \cdot 3 = 1$. Is Herb correct? Explain.

_____

_____

_____

_____

_____

LESSON

13.3 Volume of Spheres

COMMON CORE 8.G.9

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

**? ESSENTIAL QUESTION**

How do you find the volume of a sphere?

EXPLORE ACTIVITY COMMON CORE 8.G.9

Modeling the Volume of a Sphere

A **sphere** is a three-dimensional figure with all points the same distance from the center. The **radius** of a sphere is the distance from the center to any point on the sphere.

You have seen that a cone fills $\frac{1}{3}$ of a cylinder of the same radius and height h. If you were to do a similar experiment with a sphere of the same radius, you would find that a sphere fills $\frac{2}{3}$ of the cylinder. The cylinder's height is equal to twice the radius of the sphere.

$h = 2r$ $h = 2r$ $h = 2r$
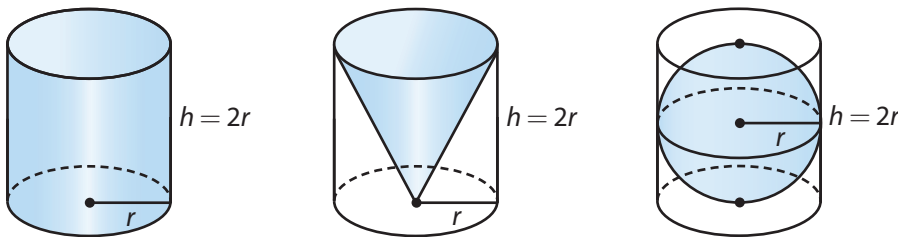
STEP 1 Write the formula $V = Bh$ for each shape. Use $B = \pi r^2$ and substitute the fractions you know for the cone and sphere.

Cylinder	**Cone**	**Sphere**
$V = \pi r^2 h$	$V = \frac{1}{3}\pi r^2 h$	$V = \frac{2}{3}\pi r^2 h$

STEP 2 Notice that a sphere always has a height equal to twice the radius. Substitute $2r$ for h.

$V = \frac{2}{3}\pi r^2(2r)$

STEP 3 Simplify this formula for the volume of a sphere.

$V = \boxed{}\,\pi r^3$

Reflect

1. **Analyze Relationships** A cone has a radius of r and a height of $2r$. A sphere has a radius of r. Compare the volume of the sphere and cone.
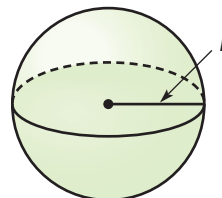
_____

_____

_____

Finding the Volume of a Sphere Using a Formula

The Explore Activity illustrates a formula for the volume of a sphere with radius *r*.

Volume of a Sphere

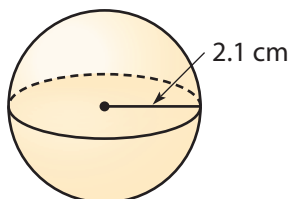| The volume *V* of a sphere is $\frac{4}{3}\pi$ times the cube of the radius *r*.	
$V = \frac{4}{3}\pi r^3$	

EXAMPLE 1

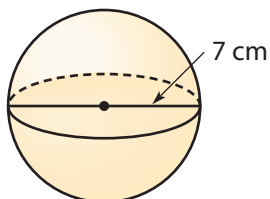**Find the volume of each sphere. Round your answers to the nearest tenth if necessary. Use 3.14 for π.**

A

2.1 cm

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

$$\approx \frac{4}{3} \cdot 3.14 \cdot 2.1^3 \qquad \text{Substitute.}$$

$$\approx \frac{4}{3} \cdot 3.14 \cdot 9.26 \qquad \text{Simplify.}$$

$$\approx 38.8 \qquad \text{Multiply.}$$

The volume is about 38.8 cm³.

Math Talk
Mathematical Practices

If you know the diameter of a sphere, how would the formula for the volume of a sphere be written in terms of *d*?

B

7 cm

Since the diameter is 7 cm, the radius is 3.5 cm.

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

$$\approx \frac{4}{3} \cdot 3.14 \cdot 3.5^3 \qquad \text{Substitute.}$$

$$\approx \frac{4}{3} \cdot 3.14 \cdot 42.9 \qquad \text{Simplify.}$$

$$\approx 179.6 \qquad \text{Multiply.}$$

The volume is about 179.6 cm³.

YOUR TURN

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

2. A sphere has a radius of 10 centimeters. _____

3. A sphere has a diameter of 3.4 meters. _____

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

Many sports, including golf and tennis, use a ball that is spherical in shape.

EXAMPLE 2 — Real World

COMMON CORE 8.G.9

Soccer balls come in several different sizes. One soccer ball has a diameter of 22 centimeters. What is the volume of this soccer ball? Round your answer to the nearest tenth. Use 3.14 for π.

STEP 1 Find the radius.

$$r = \frac{d}{2} = 11 \text{ cm}$$

STEP 2 Find the volume of the soccer ball.

$$V = \frac{4}{3}\pi r^3$$
$$\approx \frac{4}{3} \cdot 3.14 \cdot 11^3 \qquad \text{Substitute.}$$
$$\approx \frac{4}{3} \cdot 3.14 \cdot 1331 \qquad \text{Simplify.}$$
$$\approx 5572.4533 \qquad \text{Multiply.}$$

The volume of the soccer ball is about 5572.5 cm³.

Reflect

4. What is the volume of the soccer ball in terms of π, to the nearest whole number multiple? Explain your answer.

_____

_____

5. **Analyze Relationships** The diameter of a basketball is about 1.1 times that of a soccer ball. The diameter of a tennis ball is about 0.3 times that of a soccer ball. How do the volumes of these balls compare to that of a soccer ball? Explain.

_____

_____

_____

YOUR TURN

6. Val measures the diameter of a ball as 12 inches. How many cubic inches of air does this ball hold, to the nearest tenth? Use 3.14 for π.

_____
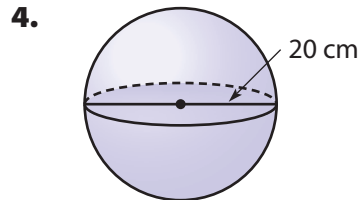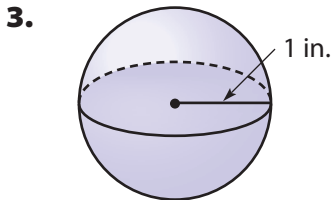
Guided Practice

1. **Vocabulary** A sphere is a three-dimensional figure with all points

   _____ from the center. (Explore Activity)

2. **Vocabulary** The _____ is the distance from the center
   of a sphere to a point on the sphere. (Explore Activity)

**Find the volume of each sphere. Round your answers to the nearest tenth
if necessary. Use 3.14 for π. (Example 1)**

3.

1 in.

_____

4.

20 cm

_____

5. A sphere has a radius of 1.5 feet. _____

6. A sphere has a diameter of 2 yards. _____

7. A baseball has a diameter of 2.9 inches. Find the volume of the baseball. Round
   your answer to the nearest tenth if necessary. Use 3.14 for π. (Example 2)   _____

8. A basketball has a radius of 4.7 inches. What is its volume to the nearest
   cubic inch. Use 3.14 for π. (Example 2)   _____

9. A company is deciding whether to package a ball
   in a cubic box or a cylindrical box. In either case,
   the ball will touch the bottom, top, and sides.
   (Explore Activity)
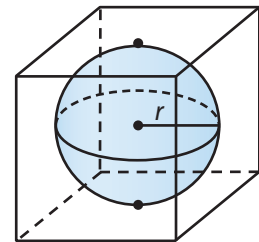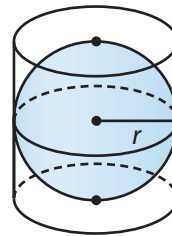
   a. What portion of the space inside the cylindrical
      box is empty? Explain.

      _____

   b. Find an expression for the volume of the cubic box. _____

   c. About what portion of the space inside the cubic box is empty? Explain.

      _____

      _____

? ESSENTIAL QUESTION CHECK-IN

10. Explain the steps you use to find the volume of a sphere.

   _____

13.3 Independent Practice
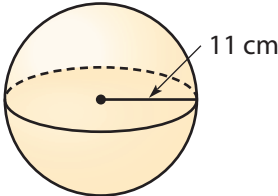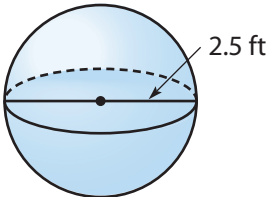
COMMON CORE 8.G.9

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

11. radius of 3.1 meters _____

12. diameter of 18 inches _____

13. $r = 6$ in. _____

14. $d = 36$ m _____

15.

11 cm

_____

16.

2.5 ft

_____

The eggs of birds and other animals come in many different shapes and sizes. Eggs often have a shape that is nearly spherical. When this is true, you can use the formula for a sphere to find their volume.

17. The green turtle lays eggs that are approximately spherical with an average diameter of 4.5 centimeters. Each turtle lays an average of 113 eggs at one time. Find the total volume of these eggs, to the nearest cubic centimeter.

_____

18. Hummingbirds lay eggs that are nearly spherical and about 1 centimeter in diameter. Find the volume of an egg. Round your answer to the nearest tenth.

_____

19. Fossilized spherical eggs of dinosaurs called titanosaurid sauropods were found in Patagonia. These eggs were 15 centimeters in diameter. Find the volume of an egg. Round your answer to the nearest tenth.

_____

20. Persevere in Problem Solving An ostrich egg has about the same volume as a sphere with a diameter of 5 inches. If the eggshell is about $\frac{1}{12}$ inch thick, find the volume of just the shell, not including the interior of the egg. Round your answer to the nearest tenth.

_____

21. Multistep Write the steps you would use to find a formula for the volume of the figure at right. Then write the formula.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____
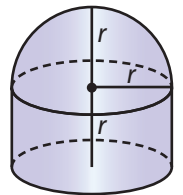
22. Critical Thinking Explain what happens to the volume of a sphere if you double the radius.

_____

23. Multistep A cylindrical can of tennis balls holds a stack of three balls so that they touch the can at the top, bottom, and sides. The radius of each ball is 1.25 inches. Find the volume inside the can that is not taken up by the three tennis balls.

_____

H.O.T. 🌶 **FOCUS ON HIGHER ORDER THINKING**

24. Critique Reasoning A sphere has a radius of 4 inches, and a cube-shaped box has an edge length of 7.5 inches. J.D. says the box has a greater volume, so the sphere will fit in the box. Is he correct? Explain.

_____

_____

_____

25. Critical Thinking Which would hold the most water: a bowl in the shape of a hemisphere with radius r, a cylindrical glass with radius r and height r, or a cone-shaped drinking cup with radius r and height r? Explain.

_____

_____

_____

26. Analyze Relationships Hari has models of a sphere, a cylinder, and a cone. The sphere's diameter and the cylinder's height are the same, $2r$. The cylinder has radius r. The cone has diameter $2r$ and height $2r$. Compare the volumes of the cone and the sphere to the volume of the cylinder.

_____

_____

_____

27. A spherical helium balloon that is 8 feet in diameter can lift about 17 pounds. What does the diameter of a balloon need to be to lift a person who weighs 136 pounds? Explain.
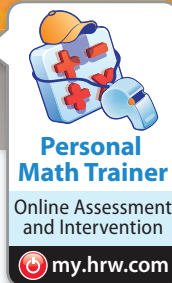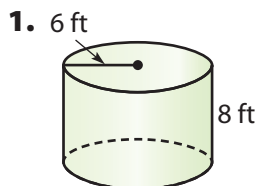
_____

_____

_____

Ready to Go On?

13.1 Volume of Cylinders

Find the volume of each cylinder. Round your answers to the nearest tenth if necessary. Use 3.14 for π.
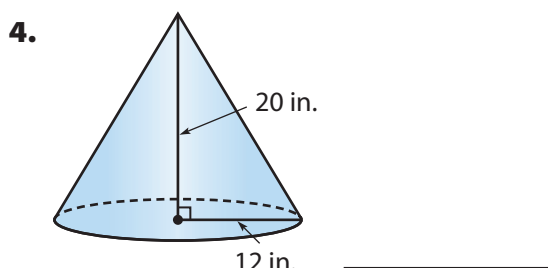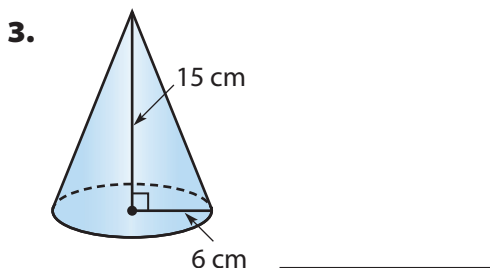
1. 6 ft

8 ft

_____

2. A can of juice has a radius of 4 inches and a height of 7 inches. What is the volume of the can?

_____

13.2 Volume of Cones

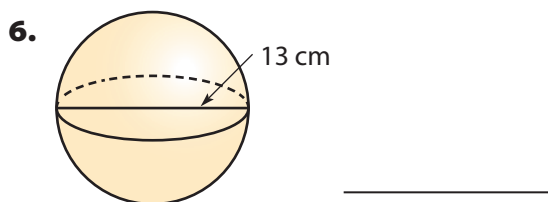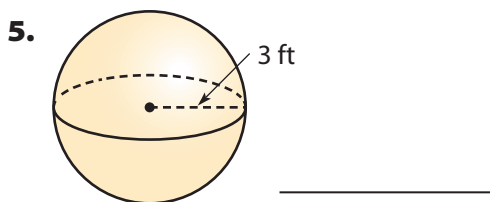**Find the volume of each cone. Round your answers to the nearest tenth if necessary. Use 3.14 for π.**

3.

15 cm

6 cm _____

4.

20 in.

12 in. _____

13.3 Volume of Spheres

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

5. 3 ft

_____

6. 13 cm

_____

? ESSENTIAL QUESTION

7. What measurements do you need to know to find the volume of a cylinder? a cone? a sphere?

_____

_____

MODULE 13 MIXED REVIEW

COMMON CORE

Assessment Readiness

Personal Math Trainer

Online Assessment and Intervention
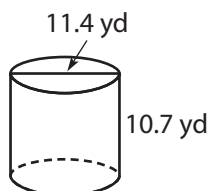
my.hrw.com

Selected Response

1. The bed of a pickup truck measures 4 feet by 8 feet. To the nearest inch, what is the length of the longest thin metal bar that will lie flat in the bed?

  Ⓐ 11 ft 3 in.   Ⓒ 8 ft 11 in.

  Ⓑ 10 ft 0 in.   Ⓓ 8 ft 9 in.

2. Using 3.14 for π, what is the volume of the cylinder below to the nearest tenth?

11.4 yd

10.7 yd

  Ⓐ 102 cubic yards

  Ⓑ 347.6 cubic yards

  Ⓒ 1,091.6 cubic yards

  Ⓓ 4,366.4 cubic yards

3. Rhett made mini waffle cones for a birthday party. Each waffle cone was 3.5 inches high and had a radius of 0.8 inches. What is the volume of each cone to the nearest hundredth?

  Ⓐ 1.70 cubic inches

  Ⓑ 2.24 cubic inches

  Ⓒ 2.34 cubic inches

  Ⓓ 8.79 cubic inches

4. What is the volume of a cone that has a height of 17 meters and a base with a radius of 6 meters? Use 3.14 for π and round to the nearest tenth.

  Ⓐ 204 cubic meters

  Ⓑ 640.6 cubic meters
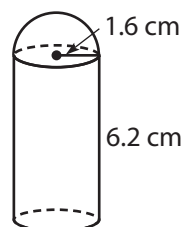
  Ⓒ 2,562.2 cubic meters

  Ⓓ 10,249 cubic meters

5. Using 3.14 for π, what is the volume of the sphere to the nearest tenth?

22 cm
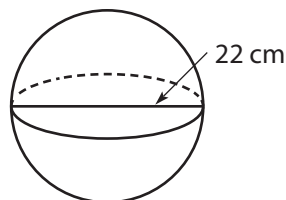
  Ⓐ 4180 cubic centimeters

  Ⓑ 5572.5 cubic centimeters

  Ⓒ 33,434.7 cubic centimeters

  Ⓓ 44,579.6 cubic centimeters

Mini-Task

6. A diagram of a deodorant container is shown. It is made up of a cylinder and half of a sphere.

1.6 cm

6.2 cm

Use 3.14 for π and round answers to the nearest tenth.

  a. What is the volume of the half sphere?

  _____

  b. What is the volume of the cylinder?

  _____

  c. What is the volume of the whole figure?

  _____