LESSON

13.3 Volume of Spheres

FL 8.G.3.9

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

ESSENTIAL QUESTION

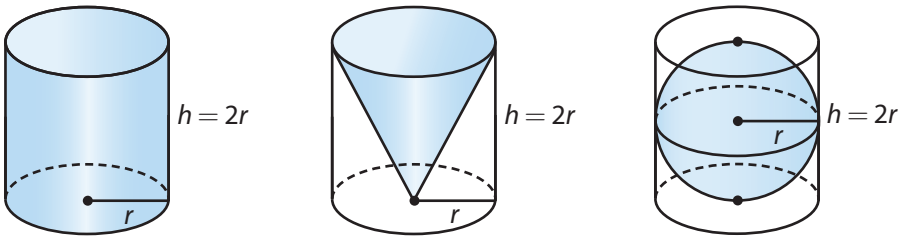
How do you find the volume of a sphere?

EXPLORE ACTIVITY FL 8.G.3.9

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.



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.

$V = \square\,\pi r^3$

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.

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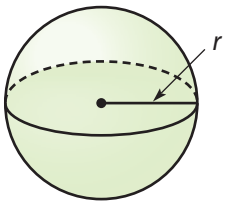
Finding the Volume of a Sphere Using a Formula

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

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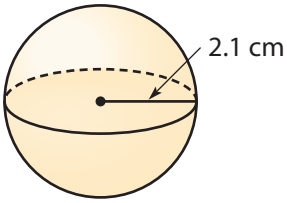
Find the volume of each sphere. Round your answers to the nearest tenth if necessary. Use 3.14 for π.

A



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

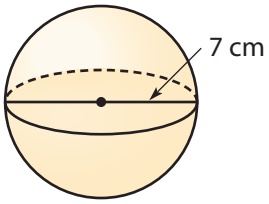
$\approx \frac{4}{3} \cdot 3.14 \cdot 2.1^3$ Substitute.

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

≈ 38.8 Multiply.

The volume is about $38.8\ \text{cm}^3$.

B



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

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

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

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

≈ 179.6 Multiply.

The volume is about $179.6\ \text{cm}^3$.

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?

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. _____

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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.

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EXAMPLE 2

Real World

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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.

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

STEP 2 Find the volume of the soccer ball.

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

$\approx \frac{4}{3} \cdot 3.14 \cdot 11^3$ Substitute.

$\approx \frac{4}{3} \cdot 3.14 \cdot 1331$ Simplify.

≈ 5572.4533 Multiply.

The volume of the soccer ball is about 5572.5 cm^3.

Reflect

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

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_____

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.

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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.

_____

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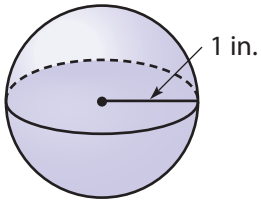
Guided Practice

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. 

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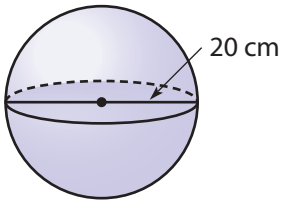
4. 

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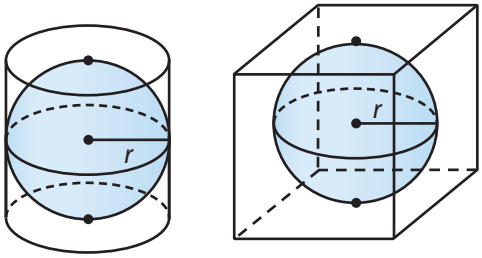
5. A sphere has a radius of 1.5 feet. _____

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.

_____

Name _____ Class _____ Date _____

13.3 Independent Practice

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

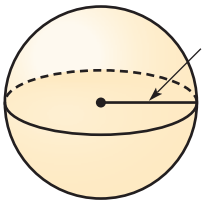
11. radius of 3.1 meters _____

12. diameter of 18 inches _____

13. $r = 6$ in. _____

14. $d = 36$ m _____

15.



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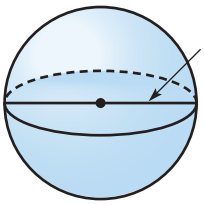

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The eggs of birds and other animals come in many different shapes and sizes. Eggs often have a shape that is nearly spherical. When this is true, you can use the formula for a sphere to find their volume.

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.

_____

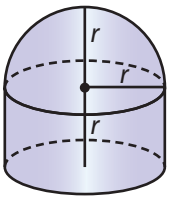
19. Fossilized spherical eggs of dinosaurs called titanosaurid sauropods were found in Patagonia. These eggs were 15 centimeters in diameter. Find the volume of an egg. Round your answer to the nearest tenth.

_____

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.



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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.

Work Area

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.