

## © CONTENT STANDARDS

8.G.9

**What You'll Learn**

To find the surface area and volume of a sphere

🔊 **New Vocabulary** sphere

**Why Learn This?**

Many objects have the shape of a sphere, including toys. To make these objects, it is helpful to know about the surface area and volume of spheres.

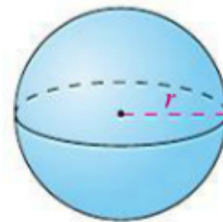


A **sphere** is the set of all points in space that are the same distance from a center point.

**KEY CONCEPTS** Surface Area of a Sphere

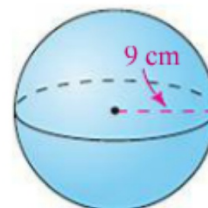
The surface area of a sphere is four times the product of  $\pi$  and the square of the radius  $r$ .

$$\text{S.A.} = 4\pi r^2$$



**EXAMPLE****Finding the Surface Area of a Sphere**

- 1 Find the surface area of the sphere at the right to the nearest square centimeter.



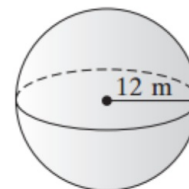
$$\begin{aligned} \text{S.A.} &= 4\pi r^2 && \leftarrow \text{surface area of a sphere} \\ &= 4\pi(9^2) && \leftarrow \text{Substitute.} \\ &= 324\pi && \leftarrow \text{Simplify.} \\ &\approx 1017.87602 && \leftarrow \text{Use a calculator.} \end{aligned}$$

The surface area of the sphere is about 1,018 cm<sup>2</sup>.

**Example**

- 1 **Finding the Surface Area of a Sphere** Find the surface area of a sphere with a radius of 12 m to the nearest whole unit.

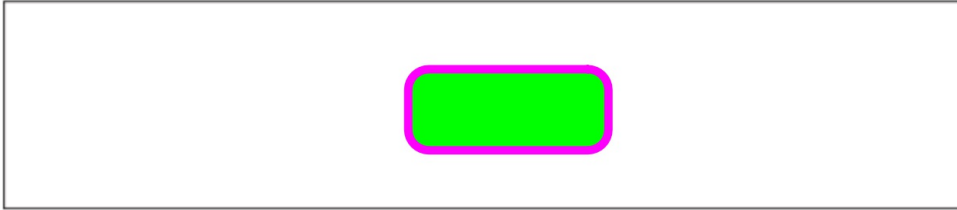
$$\begin{aligned} \text{S.A.} &= 4\pi r^2 && \leftarrow \text{surface area of a sphere} \\ &= 4\pi(12)^2 && \leftarrow \text{Substitute 12 for } r. \\ &= 576\pi && \leftarrow \text{Simplify.} \\ &\approx 1809.557368 && \leftarrow \text{Use a calculator.} \end{aligned}$$



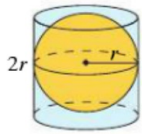
The surface area of the sphere is about 1,810 m<sup>2</sup>.

## Quick Check

1. A sphere has a radius of 7 ft. Find its surface area to the nearest square foot.



Consider a sphere with radius  $r$  inside a cylinder with radius  $r$  and height  $2r$ . You know how to find the volume of the cylinder.



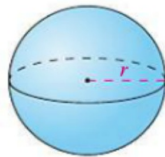
$$\begin{aligned} V &= Bh && \leftarrow \text{volume of a cylinder} \\ &= (\pi r^2)(2r) && \leftarrow \text{Substitute } \pi r^2 \text{ for } B \text{ and } 2r \text{ for } h. \\ &= 2\pi r^3 && \leftarrow \text{Simplify.} \end{aligned}$$

The volume of the sphere is two thirds of the volume of the cylinder.

### KEY CONCEPTS Volume of a Sphere

The volume of a sphere is four thirds of the product of  $\pi$  and the radius  $r$  cubed.

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





## EXAMPLE

### Finding the Volume of a Sphere

**2 Gridded Response** The diameter of a sphere in a water fountain is 4 ft. What is the volume of the sphere to the nearest cubic foot?

**Estimate** Use 3 for  $\pi$ . The radius of the sphere is 2 ft. The volume of the sphere is about  $\frac{4}{3}(3)(2)^3 = 32 \text{ ft}^3$ .

$$\begin{aligned}
 V &= \frac{4}{3}\pi r^3 && \leftarrow \text{volume of a sphere} \\
 &= \frac{4}{3}\pi(2^3) && \leftarrow \text{Substitute 2 for } r. \\
 &= \frac{32}{3}\pi && \leftarrow \text{Simplify.} \\
 &\approx 33.51032164 && \leftarrow \text{Use a calculator.}
 \end{aligned}$$

The volume of the sphere is about  $34 \text{ ft}^3$ .

**Check for Reasonableness** The answer  $34 \text{ ft}^3$  is close to the estimate of  $32 \text{ ft}^3$ . The answer is reasonable.

		3	4
←	←	←	←
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

## Example

**2 Finding the Volume of a Sphere** A standard men's basketball has a diameter of 9.39 inches. What is the volume of a standard men's basketball to the nearest cubic inch?

$$r = \frac{9.39}{2} \quad \leftarrow \text{The radius is equal to half the diameter.}$$

$$\approx 4.7 \text{ in.} \quad \leftarrow \text{Round to the nearest tenth of an inch.}$$

$$V = \frac{4}{3}\pi r^3 \quad \leftarrow \text{volume of a sphere}$$

$$\approx \frac{4}{3}\pi(4.7)^3 \quad \leftarrow \text{Substitute 4.7 for } r.$$

$$\approx 434.892765 \quad \leftarrow \text{Use a calculator.}$$

The volume of a standard men's basketball is about  $435 \text{ in.}^3$ .

**Check for Reasonableness** Use 3 for  $\pi$  and 5 for  $r$ . The volume is about  $\frac{4}{3}(3)(5)^3 \text{ in.}^3$ , or  $500 \text{ in.}^3$ . The answer **is** reasonable.

### Quick Check

2. A globe in a brass stand has a diameter of 40 in. What is the volume of the globe to the nearest cubic inch?



### Check Your Understanding

**Vocabulary** Match each solid's definition with the correct term.

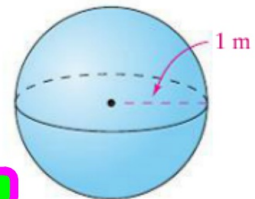
- |                                                                              |                      |             |
|------------------------------------------------------------------------------|----------------------|-------------|
| 1. exactly one circular base and one vertex                                  | <input type="text"/> | A. cylinder |
| 2. two bases that are parallel, congruent circles                            | <input type="text"/> | B. sphere   |
| 3. set of all points in space that are the same distance from a center point | <input type="text"/> | C. cone     |

Use the sphere at the right for Exercises 4–6.

4. Which is the correct expression for the surface area of the sphere:  $\frac{4}{3}(3.14)(1)^3$  or  $4(3.14)(1)^2$ ?

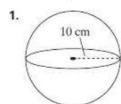
5. What is the surface area of the sphere?

6. What is the volume of the sphere?



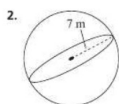
**Practice 9-4** Spheres

Find each sphere's surface area and volume to the nearest whole number.



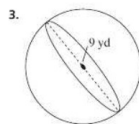
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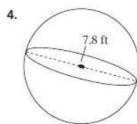
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5. A sphere has a radius of 9 ft. Find its surface area to the nearest whole square unit.

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6. A geography professor has a spherical globe with a diameter of 14 in. What is the volume of the globe?

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7. Jenny has four marbles that are all of different sizes and colors. They have diameters of 18 mm, 19 mm, 21 mm, and 24 mm. What is the average surface area of the four marbles?

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