

9.6

Surface Area and Volume of Spheres

Goal

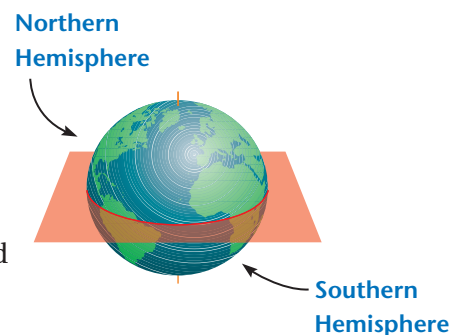
Find surface areas and volumes of spheres.

Key Words

- sphere
- hemisphere

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

A geometric plane passing through the center of a sphere divides it into two **hemispheres**. The globe is divided into the Northern Hemisphere and the Southern Hemisphere.

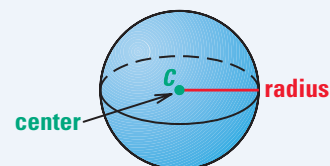


The globe is divided into two hemispheres.

SURFACE AREA OF A SPHERE

Words Surface area = $4\pi(\text{radius})^2$

Symbols $S = 4\pi r^2$



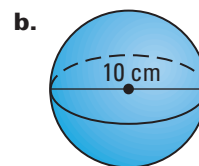
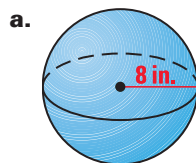
Visualize It!

To sketch a sphere, draw a **circle** and its **center**. Then draw an **oval** to give the sphere dimension.



EXAMPLE 1 Find the Surface Area of a Sphere

Find the surface area of the sphere. Round your answer to the nearest whole number.



Solution

- a. The radius is 8 inches, so $r = 8$.

$$\begin{aligned} S &= 4\pi r^2 \\ &= 4 \cdot \pi \cdot 8^2 \\ &\approx 804 \end{aligned}$$

The surface area is about 804 square inches.

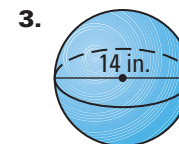
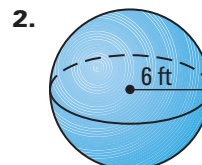
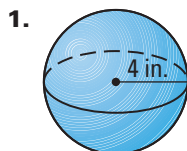
- b. The diameter is 10 cm, so the radius is $\frac{10}{2} = 5$. So, $r = 5$.

$$\begin{aligned} S &= 4\pi r^2 \\ &= 4 \cdot \pi \cdot 5^2 \\ &\approx 314 \end{aligned}$$

The surface area is about 314 square centimeters.

Checkpoint Find the Surface Area of a Sphere

Find the surface area of the sphere. Round your answer to the nearest whole number.



VOLUME OF A SPHERE

Words Volume = $\frac{4}{3}\pi(\text{radius})^3$

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

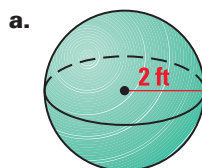


MORE EXAMPLES

More examples at
classzone.com

EXAMPLE 2 Find the Volume of a Sphere

Find the volume of the sphere or hemisphere. Round your answer to the nearest whole number.



Solution

$$\begin{aligned} \text{a. } V &= \frac{4}{3}\pi r^3 \\ &= \frac{4}{3} \cdot \pi \cdot 2^3 \\ &= \frac{32}{3}\pi \\ &\approx 34 \end{aligned}$$

Write the formula for volume of a sphere.

Substitute 2 for r .

Simplify. $2^3 = 2 \cdot 2 \cdot 2 = 8$

Multiply.

ANSWER ▶ The volume is about 34 cubic feet.

b. A hemisphere has half the volume of a sphere.

$$\begin{aligned} V &= \frac{1}{2}\left(\frac{4}{3}\pi r^3\right) \\ &= \frac{1}{2} \cdot \left(\frac{4}{3} \cdot \pi \cdot 5^3\right) \\ &= \frac{250}{3}\pi \\ &\approx 262 \end{aligned}$$

Write the formula for $\frac{1}{2}$ the volume of a sphere.

Substitute 5 for r .

Simplify. $5^3 = 5 \cdot 5 \cdot 5 = 125$

Multiply.

ANSWER ▶ The volume is about 262 cubic inches.

EXAMPLE 3 Find the Volume of a Sphere

Estimate the volume of air in a beach ball that has a 12 inch diameter. Round your answer to the nearest whole number.

**Solution**

$$V = \frac{4}{3}\pi r^3 \quad \text{Write volume formula.}$$

$$= \frac{4}{3} \cdot \pi \cdot 6^3 \quad \text{Substitute } \frac{12}{2} = 6 \text{ for } r.$$

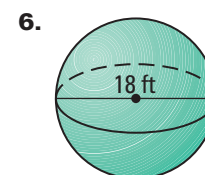
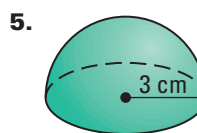
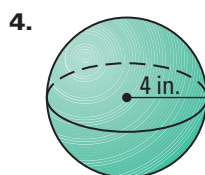
$$= 288\pi \quad \text{Simplify.}$$

$$\approx 905 \quad \text{Multiply.}$$

ANSWER ▶ The volume of air in the ball is about 905 cubic inches.

Checkpoint Find the Volume of a Sphere

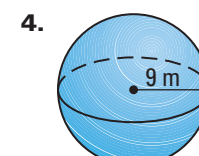
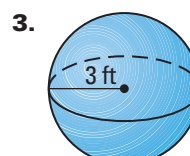
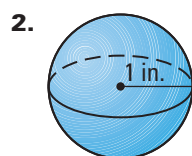
Find the volume to the nearest whole number.

**9.6 Exercises****Guided Practice****Vocabulary Check**

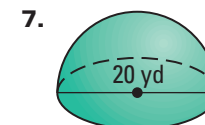
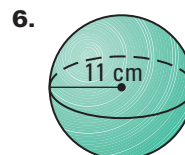
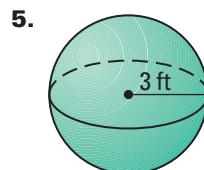
1. Explain the difference between a *sphere* and a *hemisphere*.

Skill Check

Find the surface area to the nearest whole number.



Find the volume to the nearest whole number.

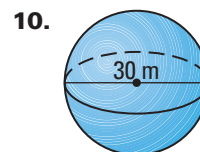
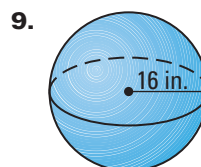
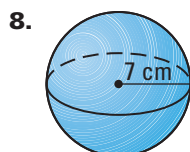


Practice and Applications

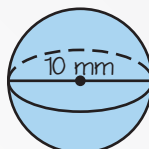
Extra Practice

See p. 692.

Find Surface Area of a Sphere Find the surface area of the sphere. Round your answer to the nearest whole number.



11. Error Analysis Bob is asked to find the surface area of a sphere with a diameter of 10 millimeters. Explain and correct his error(s).

$$\begin{aligned}
 V &= \pi r^2 \\
 &= \pi(10)^2 \\
 &= 100\pi \\
 &\approx 314 \text{ mm}^3
 \end{aligned}$$


Sports In Exercises 12–17, estimate the surface area of the ball. Round your answer to the nearest whole number.

12. Soccer ball



$r = 4.3$ in.

13. Tennis ball



$r = 3.3$ cm

14. Bowling ball



$r = 10.9$ cm

15. Golf ball



$d = 1.7$ in.

16. Basketball



$d = 9.5$ in.

17. Softball



$d = 9.6$ cm

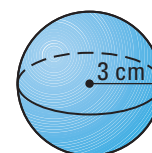
Homework Help

Example 1: Exs. 8–17

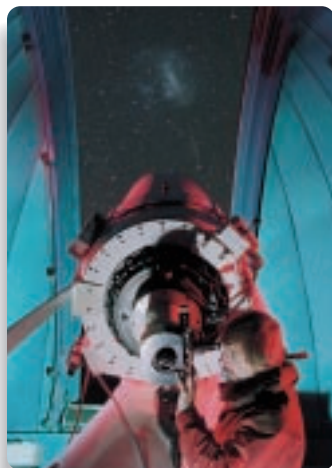
Example 2: Exs. 23–28,
37–39

Example 3: Exs. 23–28,
37–39

18. You be the Judge Julie thinks that if you double the radius of the sphere shown at the right, the surface area will double. Is she right? Explain your reasoning.



Link to Astronomy

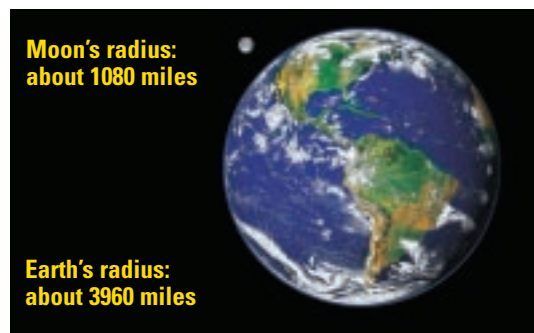


ASTRONOMERS study the planets, stars, and solar system. Powerful telescopes are used to collect information about astronomical objects.



Astronomy In Exercises 19–22, use the information about Earth and its moon given in the photo.

19. Find the surface area of Earth.
20. Find the surface area of Earth's moon.
21. Compare the surface areas of Earth and its moon.
22. About 70% of Earth's surface is water. How many square miles of water are on Earth's surface?



Finding Volume of a Sphere Find the volume of the sphere. Round your answer to the nearest whole number.

- 23.
- 24.
- 25.
- 26.
- 27.
- 28.

Technology Use formulas to create a spreadsheet like the one shown. Then answer Exercises 29–32.

Comparing Spheres			
	A	B	C
1	Radius, r	Surface area, $4\pi r^2$	$\frac{\text{Surface area of new sphere}}{\text{Surface area of original sphere}}$
2	3	113.1	1
3	6	452.4	4
4	9	?	?
5	12	?	?

29. How many times greater is the surface area of a sphere if the radius is doubled? tripled? quadrupled?
30. Explain why the surface area changes by a greater amount than the radius.
31. How many times greater do you think the volume of a sphere will be if the radius is doubled? tripled?
32. Create a spreadsheet for the volume of a sphere. Then answer Exercises 29 and 30 for the volume of a sphere.

Student Help

LOOK BACK

See pp. 470–471 for more information about The Rose Center for Earth and Space.

Spheres in Architecture In Exercises 33–36, refer to the information below about The Rose Center for Earth and Space at New York City's American Museum of Natural History.

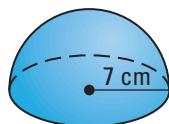
The sphere has a diameter of 87 feet. The glass cube surrounding the sphere is 95 feet long on each edge.



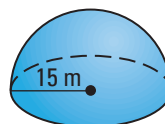
33. Find the surface area of the sphere.
34. Find the volume of the sphere.
35. Find the volume of the glass cube.
36. Find the approximate amount of glass used to make the cube. (*Hint:* Do not include the ground or roof in your calculations.)

Finding Volume of a Hemisphere Find the volume of the hemisphere. Round your answer to the nearest whole number.

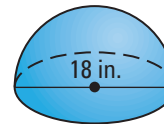
37.



38.

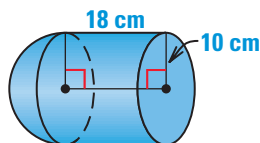


39.

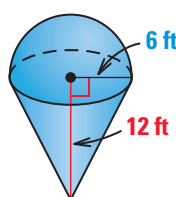


Composite Solids Find the volume of the solid. Round your answer to the nearest whole number.

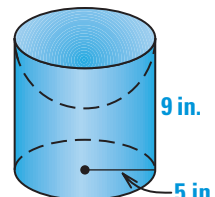
40.



41.



42.

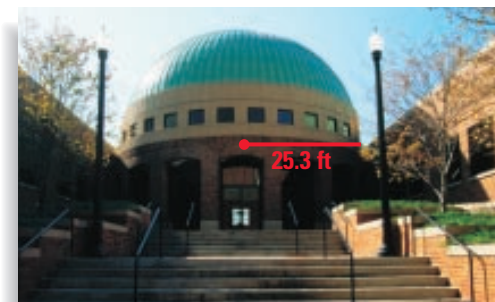


HOMESCHOOL HELP

Extra help with problem solving in Exs. 43–45 is at classzone.com

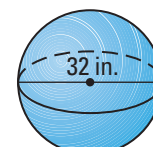
Architecture The entrance to the Civil Rights Institute in Birmingham, Alabama, includes a hemisphere that has a radius of 25.3 feet.

43. Find the volume of the hemisphere.
44. Find the surface area of the hemisphere, not including its base.
45. The walls of the hemisphere are 1.3 feet thick. So, the rounded surface inside the building is a hemisphere with a radius of 24 feet. Find its surface area, not including its base.



Standardized Test Practice

46. **Multiple Choice** What is the approximate surface area of the sphere shown?
 - (A) 3217 in.^2
 - (B) 4287 in.^2
 - (C) $12,861 \text{ in.}^2$
 - (D) $17,149 \text{ in.}^2$



Mixed Review

Surface Area Find the surface area of the solid. If necessary, round your answer to the nearest whole number. (Lessons 9.2, 9.3)

47. A cone has a height of 12 meters and a base radius of 3 meters.
48. A pyramid has a slant height of 3 feet and a square base that measures 4 feet on a side.
49. A cylinder has a radius of 9 centimeters and a height of 9 centimeters.

Simplifying Radicals Evaluate. Give the exact value if possible. Otherwise, approximate to the nearest tenth. (Skills Review, p. 668)

50. $\sqrt{6}$ 51. $\sqrt{18}$ 52. $\sqrt{77}$ 53. $\sqrt{400}$
54. $\sqrt{256}$ 55. $\sqrt{99}$ 56. $\sqrt{40}$ 57. $\sqrt{120}$

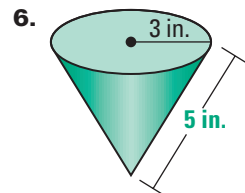
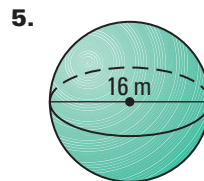
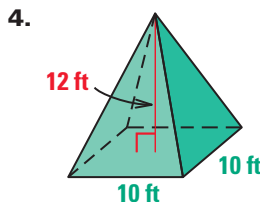
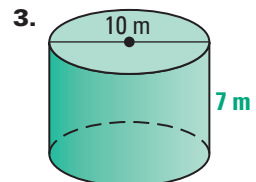
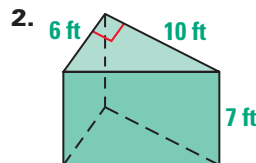
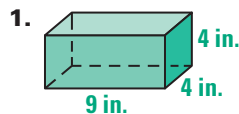
Algebra Skills

Using Formulas Find the missing length using the given information. (Skills Review, p. 674)

58. A rectangle is 6 feet wide and 11 feet long. Find the perimeter.
59. A square has an area of 100 square inches. Find the perimeter.
60. Find the width of a rectangle with a length of 8 meters and an area of 40 square meters.
61. The perimeter of a square is 44 yards. Find the side length.

Quiz 2

Find the volume of the solid. If necessary, round your answer to the nearest whole number. (Lessons 9.4, 9.5, 9.6)



7. Sketch a cylinder with a radius of 4 inches and a height of 4 inches. Then find its volume. (Lesson 9.4)
8. Sketch a sphere with a radius of 9 centimeters. Then find its surface area. (Lesson 9.6)