## Lesson 10-9
## Solve Problems Involving Volume

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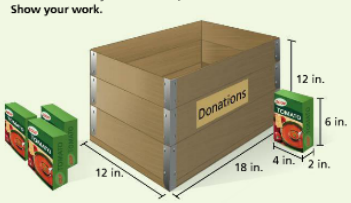
**I can...**
use the area of the base of a three-dimensional figure to find its volume.

### Solve & Discuss It!

Volunteers at a food pantry pack boxes of soup into crates. How many boxes of soup will fill each crate? Show your work.




**Look for Relationships** How can you layer the soup boxes to cover the bottom of the crate?

### Focus on math practices

**Reasoning** A supplier donated crates to the food pantry that are 15 inches long, instead of 18 inches long. All other dimensions are the same. What is the greatest number of boxes of soup that will fit in the donated crates? How will the volume of the soup vary from the total volume of the crate?

623

**Essential Question** How does the formula for volume of a prism help you understand what volume of a prism means?

### EXAMPLE 1 Find Volumes of Prisms

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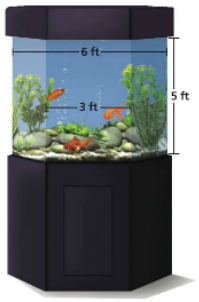
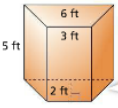
Cora has an aquarium with exotic fish. The tank is the size and shape of a trapezoidal prism. The distance from the front glass to the back is 2 feet. What is the volume of the aquarium tank?




**STEP 1** Identify the shape of the base.

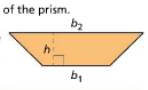



The base of the prism is a trapezoid.

**STEP 2** Find the area of the base, $B$, of the prism.

Area formula for trapezoid

$$A = \frac{1}{2}(b_1 + b_2)h$$
$$= \frac{1}{2}(3 + 6)2$$
$$= \frac{1}{2}(9)(2)$$
$$= 9 \text{ ft}^2$$




The area of the base is 9 ft$^2$.

**Model with Math** Why does this formula work?

**STEP 3** Find the volume of the prism.

Volume = Area of base of prism × height of the prism

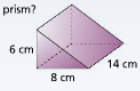
$V = Bh$
$= 9(5)$
$= 45 \text{ ft}^3$

Volume is measured in cubic units.

The volume of the aquarium tank is 45 ft$^3$.

### Try It!

What is the volume of the triangular prism?




$V = B \cdot h$
$V = \left(\frac{1}{2} \cdot \square \cdot \square\right) \cdot h$
$V = (\square) \cdot \square$
$V = \square$

The volume of the prism is ☐ cubic centimeters.

**Convince Me!** What is the shape of the base of the figure? What are its dimensions? Explain.



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## EXAMPLE 2 Solve Problems Involving Volume

**Students are selling a souvenir basketball. Will the basketball fit inside the gift box that has a regular hexagonal base so that the lid fits on top?**

STEP 1 Find the area of the hexagonal base.

Area of base = 6 • (area of one triangle in base)

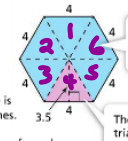
$A = 6 \cdot \left(\frac{1}{2}b \cdot h\right)$

$= 6 \cdot \frac{1}{2}(4) \cdot (3.5)$

$= \frac{1}{2}(14)$

$= 42$

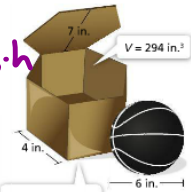
The area of the base is about 42 square inches.




You can decompose a regular hexagon into 6 equal triangles.

The height of each triangle in the base is about 3.5 inches.

$A_\triangle = \frac{1}{2} \cdot b \cdot h$




Each edge of the hexagon base is 4 inches.

STEP 2 Use the volume formula to find the height.

$V = Bh$

$294 = (42)h$

$\frac{294}{42} = \frac{42h}{42}$

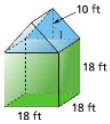
$7 = h$

The width of the box is given at 7 inches. The height of the box is 7 inches. Both the height and width are greater than the diameter of the basketball, so the basketball will fit with the lid on top of the box.

**Look for Relationships**
If you find the base area and the volume is given, can you find the height of the box?

## EXAMPLE 3 Find Volumes of Composite Figures

**Sequan has a shed for his athletic equipment. What is the total volume of the shed?**



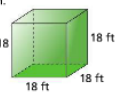

STEP 1 Find the volume of the **bottom** section.

$V = Bh$

$= (18)(18) \cdot 18$

$= 324(18)$

$= 5{,}832$




The volume of the bottom section is 5,832 cubic feet.

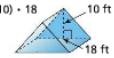
STEP 2 Find the volume of the **top** section.

$V = Bh$

$= \frac{1}{2}(18)(10) \cdot 18$

$= 90(18)$

$= 1{,}620$




The volume of the top section is 1,620 cubic feet.

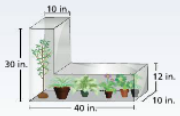
STEP 3 Add the volumes together.

$5{,}832 + 1{,}620 = 7{,}452$

The total volume of the shed is 7,452 cubic feet.

### Try It!

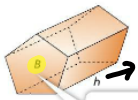
Amber built a custom terrarium for her plants. What is the volume of the terrarium?






## KEY CONCEPT

You can use formulas to solve problems involving the volume of three-dimensional figures.




→ 3rd dim.

B = area of shape

You can use the formula $V = Bh$ to find the volume or unknown dimension of a solid figure.

Find the volume of a composite figure by finding the sum of the volumes of each solid figure.

$V_\square = \ell \cdot w \cdot h$

A

↑ 3rd dimension

$V_\odot = \pi r^2 h$

$A_\odot$

height or depth

### Do You Understand?

1. **Essential Question** How does the formula for volume of a prism help you understand what volume of a prism means?

2. **Look for Relationships** If you know the volume of a three-dimensional figure, how can you find a missing dimension of the figure?

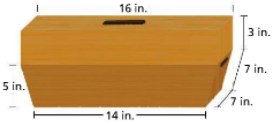
3. **Make Sense and Persevere** How do you find the volume of a three-dimensional figure that can be decomposed into prisms?

### Do You Know How?

4. An aquarium has a regular hexagonal base with side lengths of 15 centimeters. When the hexagon is divided into six equal triangles, the height of each triangle is about 13 centimeters. If the aquarium is 50 centimeters tall, what is its volume?

5. A cheese box is shaped like a right triangular prism. The box is 6 inches long, 4 inches tall, and has a volume of 24 cubic inches. Can a cube of cheese that is 2.5 inches on each side fit inside the box? Explain.


6. Ray made a toolbox with the dimensions shown to store garden tools. What is the volume of the toolbox?



B → area of shape

Name:

## Practice & Problem Solving

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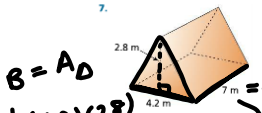
**Leveled Practice** In 7–8, find the volume of each prism.

7.




B = A_b

$\frac{1}{2}(4.2)(2.8)$ m

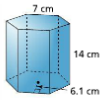
depth or height

$V = Bh$

$= (0.5 \cdot 4.2 \cdot 2.8) \cdot 7$ m ✓

$= 41.16$ m$^3$

8.



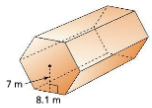

$V = Bh$

$= (0.5 \cdot \square \cdot 7 \cdot 6) \cdot \square$

$= 128.1 \cdot \square$

$= \square$ cm$^3$

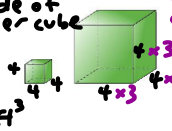
9. A tunnel for an amusement park ride has the shape of a regular hexagonal prism with dimensions shown. The prism has a volume of 3,572.1 cubic meters. Can two 8-meter cars connected by a 3-meter connector pass through the tunnel at the same time? Explain.




10. A volume of 185.5 cubic feet of concrete was used to make the section of a skateboard ramp shown. How long is the ramp?


11. **Make Sense and Persevere** A small cube has a volume of 64 cubic feet. A larger cube has sides that are three times as long as the small cube. How long are the sides of each cube?

Each side of the smaller cube is 4 ft.




Each side of the larger cube is 12 ft.

$V = 64$ ft$^3$

$B \cdot h$

$A_b$

$s \cdot s \cdot s = 64$

$4 \cdot 4 \cdot 4$

# all 3 dimensions are the same



9. A tunnel for an amusement park ride has the shape of a regular hexagonal prism with dimensions shown. The prism has a volume of 3,572.1 cubic meters. Can two 8-meter cars connected by a 3-meter connector pass through the tunnel at the same time? Explain.

$V = B \cdot h$

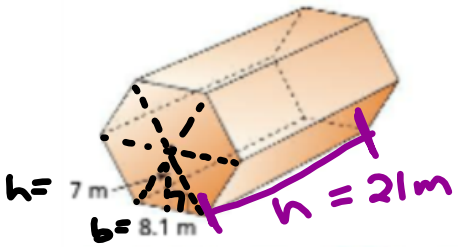
$6 \cdot \frac{1}{2} \cdot b \cdot h$

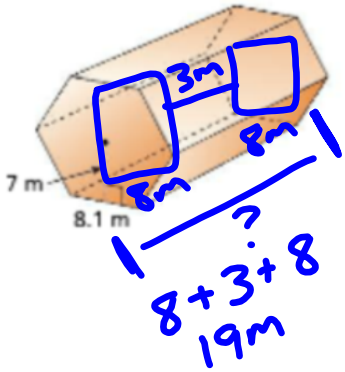
$3572.1 = 6 \cdot \frac{1}{2}(8.1)(7) \cdot h$

$3572.1 = 3(8.1)(7) \cdot h$

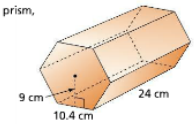
$\frac{3572.1}{170.1} = \frac{170.1 \cdot h}{170.1}$

$21 \text{ m} = h$

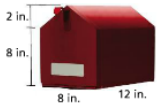


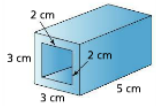
12. What is the volume of the regular hexagonal prism, to the nearest cubic centimeter?




13. A mailbox has the dimensions shown. What is the volume of the mailbox?



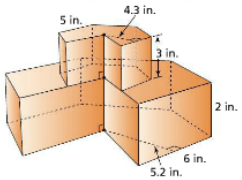

14. **Use Structure** A glass bead has the shape of a prism with a rectangular prism removed. What is the volume of the glass that forms the bead?




15. **Higher Order Thinking** A cake has two layers. Each layer is a regular hexagonal prism. A slice removes one face of each prism, as shown.

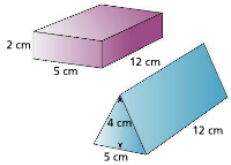
a. What is the volume of the slice?

b. What is the volume of the remaining cake?




## Assessment Practice

16. Ben uses clay to make the rectangular prism. Naomi uses cardboard to make the triangular prism. How do the volumes of the prisms compare? Explain.




17. Freezer A has interior dimensions of 1 foot by 1 foot by 5 feet and sells for $499.99. Freezer B has interior dimensions of 1.5 feet by 1.5 feet by 4 feet and sells for $849.99. Which freezer is a better buy in terms of dollars per cubic foot? Explain.