Explore

Name:_____

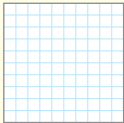## Main Idea

I will explore using models to find the surface area of rectangular prisms.

Materials

grid paper

scissors

Get ConnectED

GLE 0506.4.2 Describe polyhedral solids and analyze their properties, including volume and surface area. **SPI 0506.4.4** Solve problems involving surface area and volume of rectangular prisms and polyhedral solids. Also addresses GLE 0506.1.4.

Surface Area of Prisms

Suppose you want to paint all of the surfaces of the prism. You would need to find the surface area of this prism.
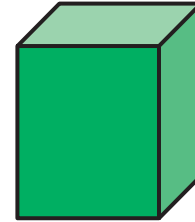
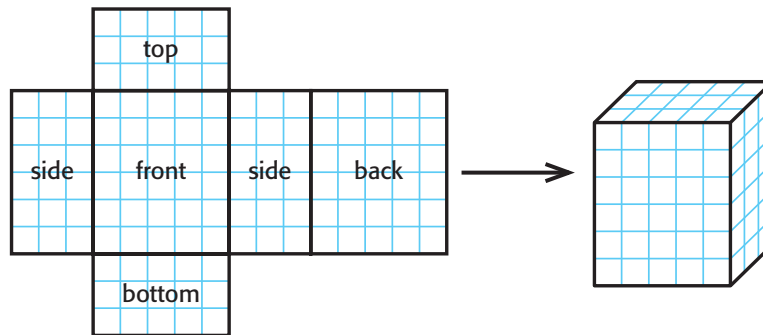To find the *surface area,* you add the areas of all the faces of the prism.

ACTIVITY

1. **Create a net to find the surface area of the prism.**

   Step 1 Draw and cut out the net below.

   Step 2 Fold along the solid black lines. Tape the edges together to form a prism.

   Step 3 Find the area of each of the six faces of the prism.

Face	front and back	top and bottom	two sides
Model			
Area (units^2)	30	15	18

   Step 4 **Find the sum of the areas.**

   $A = 30 + 30 + 15 + 15 + 18 + 18$
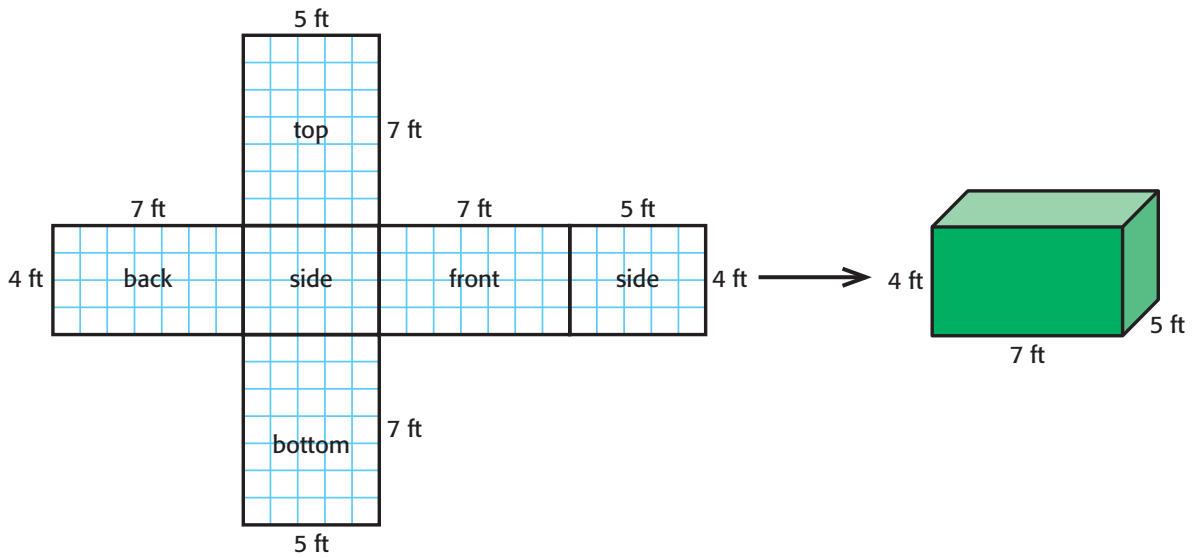
   $A = 126$ units^2 Surface area has square units because it measures area.

2 **Find the surface area of the rectangular prism.**

```
                    5 ft

              ┌──────────┐
              │          │
              │   top    │ 7 ft
              │          │
    7 ft          7 ft       5 ft
  ┌──────┬──────────┬──────────┬──────────┐
  │      │          │          │          │
4 ft│ back │  side    │  front   │  side    │ 4 ft  ──→  4 ft
  │      │          │          │          │
  └──────┴──────────┴──────────┴──────────┘
              │          │
              │ bottom   │ 7 ft
              │          │
              └──────────┘
                  5 ft
```

5 ft · 7 ft · 4 ft prism

Find the area of each face. Then add.

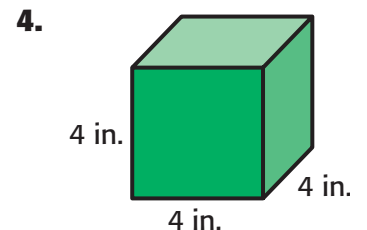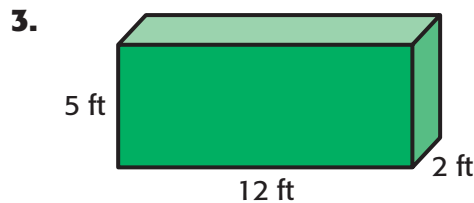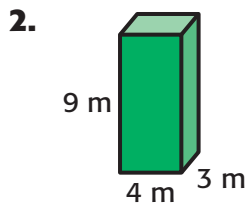| Face	front and back	top and bottom	two sides
Model	▭	▯	▫
Area (ft²)	28	35	20

$A = 28 + 28 + 35 + 35 + 20 + 20$ or 166 square feet

Think **About It**

1. Describe the faces of a cube. Explain how to find the surface area of a cube.

Practice **and Apply It**

Make a net to find the surface area of each rectangular prism.

2.
9 m
4 m   3 m

3.
5 ft
12 ft   2 ft

4.
4 in.
4 in.   4 in.

5. 🗨 **WRITE MATH** How many pairs of congruent faces are in a rectangular prism? Describe them.

Main Idea

I will find the surface area of rectangular prisms.

Vocabulary

surface area

Get ConnectED

GLE 0506.4.2
Describe polyhedral solids and analyze their properties, including volume and surface area. **SPI 0506.4.4** *Solve problems involving surface area and volume of rectangular prisms and polyhedral solids.* Also addresses GLE 0506.1.6.

Surface Area of Prisms

The sum of the areas of all the faces of a prism is called the **surface area** of the prism. Each face of a rectangular prism has a congruent opposite face. So, the following formula can also be used to find surface area.

Key Concept — **Surface Area of a Rectangular Prism**

Words   To find the surface area of a rectangular prism, add the areas of all the faces of the prism.

Model
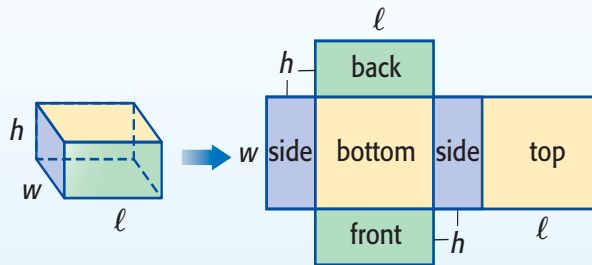
Symbols $S.A. = 2\ell h + 2\ell w + 2hw$

REAL-WORLD EXAMPLE — **Find the Surface Area**

1   **GIFTS** Find the surface area for the amount of wrapping paper needed to cover the gift.
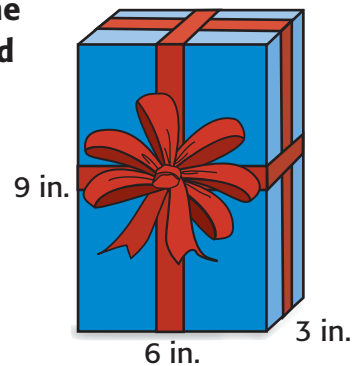

Find the area of each face.

top and bottom:
$2\ell w = 2 \times 6 \times 3$ or 36

front and back:
$2\ell h = 2 \times 6 \times 9$ or 108

two sides:
$2wh = 2 \times 3 \times 9$ or 54

Add to find the surface area.

The surface area is $36 + 108 + 54$ or 198 square inches.

Remember

Area is the number of square units needed to cover a region. It is measured in square units.

2 CAMERAS Digital cameras are made small enough to fit in a pocket. This camera is shaped like a rectangular prism. Find the surface area of the camera.

2 in.

4 in.

6 in.

Find the area of each face.

top and bottom: $2\ell w = 2 \times 6 \times 2$ or 24

front and back: $2\ell h = 2 \times 6 \times 4$ or 48

two sides: $2wh = 2 \times 2 \times 4$ or 16

Add to find the surface area.

The surface area is 24 + 48 + 16 or 88 square inches.

✓ CHECK What You Know

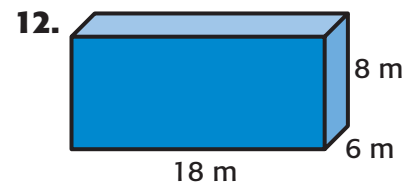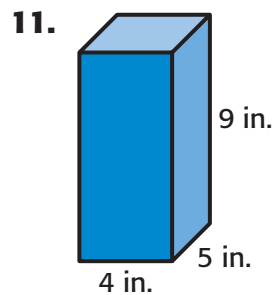**Find the surface area of each rectangular prism.** See Examples 1 and 2

1.

5 ft

3 ft
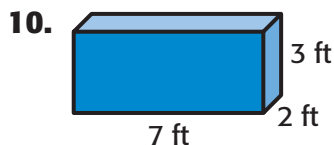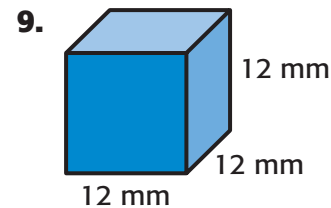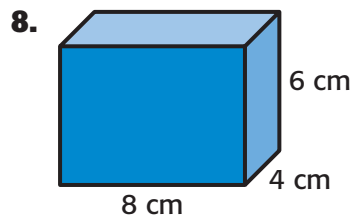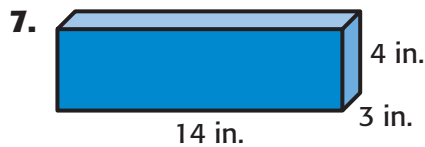
9 ft

2.

11 mm

12 mm

7 mm

3.

6 in.

2 in.

15 in.
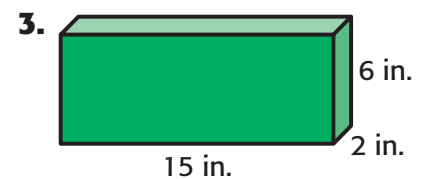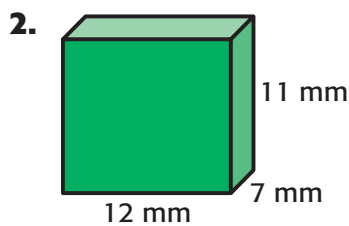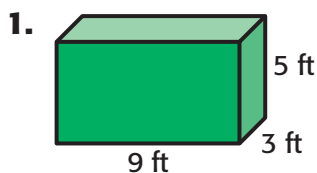
4. A box of animal crackers is shaped like a rectangular prism. What is the surface area of the box of crackers?

4 cm

5 cm

7 cm

ANIMAL CRACKERS

5. Find the surface area of a rectangular prism with a length of 9 meters, a width of 7 meters, and a height of 4 meters.
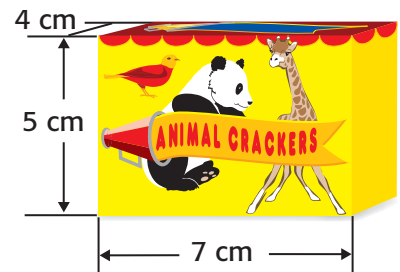
6. **TALK MATH** The formula for the surface area of a rectangular prism is $S.A. = 2\ell w + 2\ell h + 2wh$. Explain why there are three 2s in the formula.

Find the surface area of each rectangular prism. See Examples 1 and 2

7.

4 in.
3 in.
14 in.

8.

6 cm
4 cm
8 cm

9.

12 mm
12 mm
12 mm

10.

3 ft
2 ft
7 ft

11.

9 in.
5 in.
4 in.

12.

8 m
6 m
18 m

13. Alyssa owns a toolbox that is 16 inches by 22 inches by 5 inches. What is the surface area of the toolbox?

14. Michelle put her sister's birthday present in a box with a length of 13 mm, a width of 4 mm, and a height of 8 mm. How many square millimeters of wrapping paper will Michelle need to completely cover the box?

15. A package of three golf balls comes in the box shown. What is the surface area of the box?

2 in.
7 in.
2 in.

16. Which has a greater surface area: a box that is 2 inches by 3 inches by 2 inches or a box that is 1 inch by 2 inches by 4 inches?
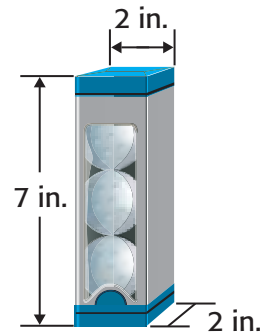
H.O.T. Problems

17. CHALLENGE What is the possible length, width, and height of a rectangular prism with the surface area of 110 square centimeters?

18. OPEN ENDED Estimate the surface area of a cereal box. Then measure and find the actual surface area. Compare to the estimate.

19. **E?** **WRITE MATH** Explain how to find the surface area of a cube without using the formula.

20. What is the surface area of the box of hot chocolate?

A. 210 in²

B. 216 in²

C. 325 in²

D. 340 in²

6 in.

10 in.

3 in.

21. For a science project, Madison uses foil to cover the outside of a can. She does not cover the top or the bottom of the can.

What two-dimensional figure represents the shape of the piece of foil that Madison uses?

F. circle

G. hexagon

H. rectangle

I. triangle

22. THINK SOLVE EXPLAIN **SHORT RESPONSE** If the area of the top of the figure shown is 16 square centimeters, what is the area of the bottom?
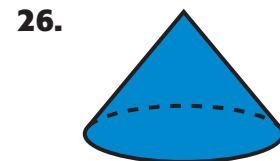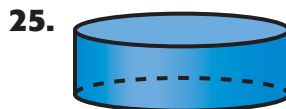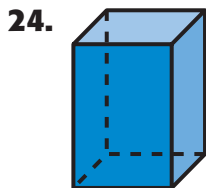
23. Which statement is true about the figure?
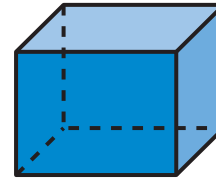
A. The figure has a triangular base.

B. The figure has exactly 3 pairs of parallel faces.

C. The figure has exactly 2 pairs of parallel faces.

D. The figure has 7 vertices.

Spiral Review

Describe the faces, edges, and vertices of each three-dimensional figure. Then identify it. (Lesson 1B)

24.

25.

26.

27. Cara made the candle shown for her mother. Describe the faces, edges, and vertices of the candle. Then identify it.

Explore

Main Idea
I will use models to find the volumes of prisms.

Materials
centimeter cubes

Get ConnectED

GLE 0506.4.2 Describe polyhedral solids and analyze their properties, including volume and surface area. *SPI 0506.4.4 Solve problems involving surface area and volume of rectangular prisms and polyhedral solids.*

Volume of Prisms

You can use centimeter cubes to build rectangular prisms like the ones shown at the right.

ACTIVITY

**Step 1** Use centimeter cubes to build four different rectangular prisms.

Step 2 For each prism, record the dimensions and the number of cubes used in a table like the one below.

Prism	Length (ℓ)	Width (w)	Height (h)	Number of Cubes
A				
B				
C				
D				

Since *volume* can be measured using cubes, volume is measured in cubic units or units^3.

Practice and Apply It

1. Describe the relationship between the dimensions of the prism and number of cubes.

2. Use ℓ, w, and h to write a formula for the volume V of a rectangular prism.

3. Use the formula you wrote in Exercise 2 to find the volume of the prism at the right in appropriate units. Verify your solution by counting the number of cubes.
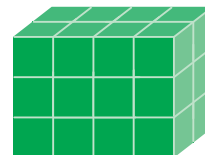
GLE 0506.4.2
Describe polyhedral solids and analyze their properties, including volume and surface area. **SPI 0506.4.4** *Solve problems involving surface area and volume of rectangular prisms and polyhedral solids.* Also addresses GLE 0506.1.6, GLE 0506.1.7.

Volume of Prisms

Volume is the amount of space inside a three-dimensional figure. Volume is measured in cubic units. A cubic unit has length, width, and height.
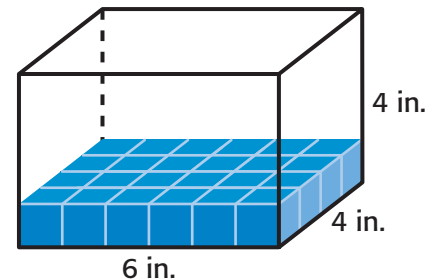
1 cubic unit

2 cubic units

4 cubic units

You can find the volume of a rectangular prism by using models. A cube with 1 unit on an edge is a standard unit for measuring volume. When cubes are placed in a prism to determine volume, there are no gaps or overlaps between the cubes.

REAL-WORLD EXAMPLE

1 **MAIL** **Evelyn wants to mail a package to her cousin. What is the volume of the package if it is 6 inches long, 4 inches wide, and 4 inches tall?**

Count the number of 1-inch cubes that will fill the bottom of the rectangular prism. The prism is 6 cubes long and 4 cubes wide. There are 24 cubes on the bottom.

There are 4 layers of cubes. So, there are 4×24 or 96 cubes.

4 in.

4 in.

6 in.

4 in.

4 in.

6 in.

Some common units of volume are *cubic inch, cubic foot, cubic yard, cubic centimeter,* and *cubic meter.*

The volume of a rectangular prism is related to its dimensions. You can use a formula to find the volume of a prism.
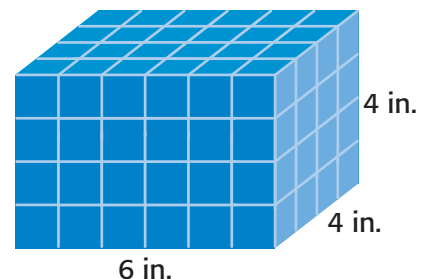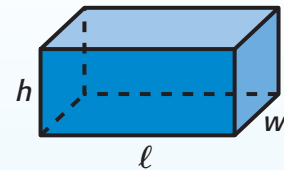
Remember

Volume measurements can be written using abbreviations and an exponent of 3.
For example:
cubic units = units^3
cubic inches = in^3
cubic feet = ft^3
cubic meters = m^3

Key Concept — Volume of a Rectangular Prism

Words To find the volume of a rectangular prism multiply the length, width, and height.

Symbols $V = \ell wh$

Model

REAL-WORLD EXAMPLE Volume of a Prism

2 **ART** Armando makes sand paintings by filling clear plastic cases with colored sand. Find the volume of the plastic case.

Estimate $5 \times 5 \times 5 = 125$

$V = \ell wh$ Formula for volume

$V = 5 \times 4 \times 7$ $\ell = 5, w = 4, h = 7$

$V = 140$ Multiply.

The volume of the prism is 140 cubic inches.

Check for Reasonableness $140 \approx 125$ ✔

7 in.

4 in. 5 in.
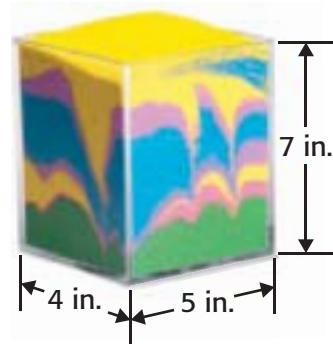
EXAMPLE Volume of a Prism

3 Find the volume of the prism.

Estimate $10 \times 10 \times 10 = 1,000$

$V = \ell wh$ Formula for volume

$V = 12 \times 9 \times 10$ $\ell = 12, w = 9, h = 10$

$V = 1,080$ Multiply.

The volume of the prism is 1,080 cm^3.

Check for Reasonableness $1,080 \approx 1,000$ ✔

9 cm

10 cm

12 cm

Find the volume of each prism. See Examples 1–3

1.

3 m
4 m
6 m

2.

4 in.
4 in.
4 in.

3.

2 cm
5 cm
9 cm
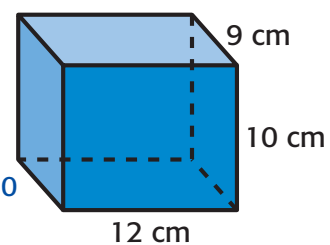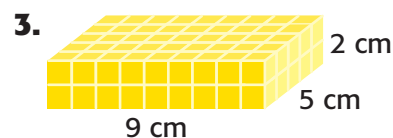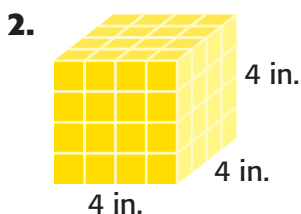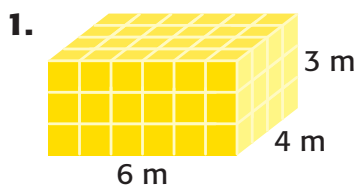
4. $\ell = 21$ cm, $w = 8$ cm, $h = 4$ cm

5. $\ell = 19$ ft, $w = 9$ ft, $h = 16$ ft

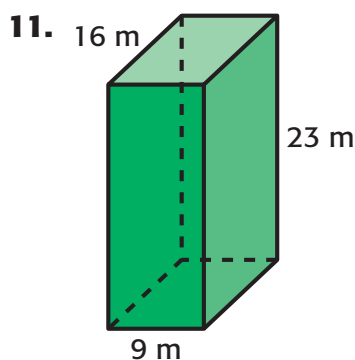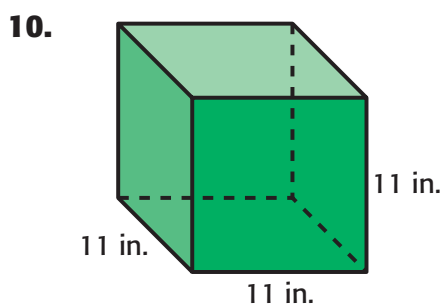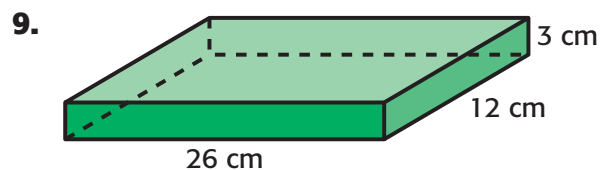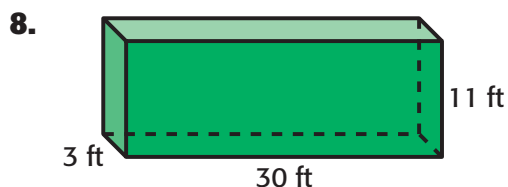**6.** Find the cubic feet of air in a room that is 13 feet long, 10 feet high, and 11 feet wide.

7. **E?** **TALK MATH** Describe which units would be appropriate to measure the volume of a jewelry box. What other units might be reasonable to use? Would it be reasonable to use the same units to measure the volume of a garage? Explain.

Practice and Problem Solving

EXTRA PRACTICE
Begins on page EP2.

Find the volume of each prism. See Examples 1–3

8.

11 ft
3 ft
30 ft

9.

3 cm
12 cm
26 cm

10.

11 in.
11 in.
11 in.

11.

16 m
23 m
9 m

12.

9 cm
17 cm
7 cm

13.

3 in.
2 in.
4 in.
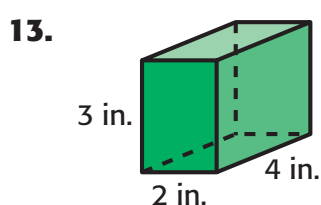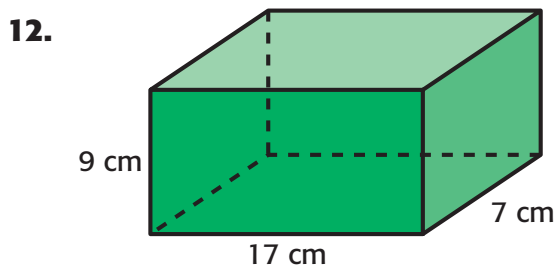
Find the volume of each prism. See Examples 1–3

14. $\ell = 5$ yd, $w = 16$ yd, $h = 6$ yd

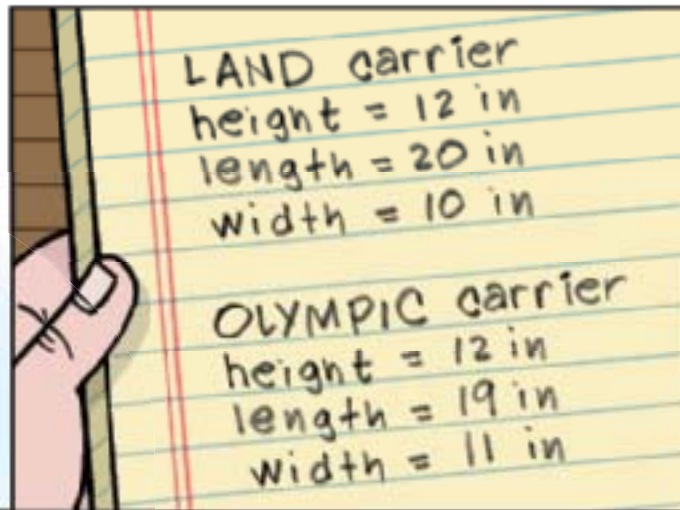**15.** $\ell = 2$ m, $w = 8$ m, $h = 10$ m

16. $\ell = 13$ in., $w = 3$ in., $h = 2$ in.

17. $\ell = 13$ cm, $w = 8$ cm, $h = 10$ cm

18. Find the volume of a bank vault that is 14 feet by 20 feet by 19 feet.

Use the information to solve the problem.

A Carrier for Kitty

Remember, I want to buy the bigger carrier for Kitty.

LAND carrier
height = 12 in
length = 20 in
width = 10 in

OLYMPIC carrier
height = 12 in
length = 19 in
width = 11 in

19. Determine the volume of each pet carrier. Which one should Emma purchase?

H.O.T. Problems

20. OPEN ENDED Estimate the volume of a shoe box. Then measure the box. Check your estimate by finding the actual volume.

21. NUMBER SENSE Describe the dimensions of two different prisms that have a volume of 2,400 cubic centimeters.

22. CHALLENGE A store sells lunch boxes that measure 11 inches by 7 inches by 4 inches. How many lunch boxes will fit in a box that measures 22 inches by 15 inches by 8 inches? Explain.


4 in.
11 in.
7 in.

8 in.
22 in.
15 in.
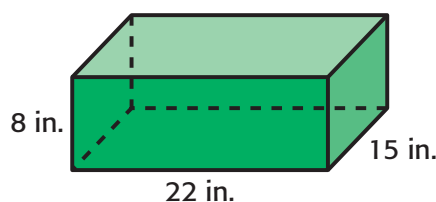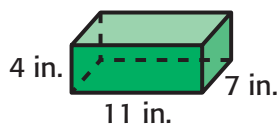
23. **WRITE MATH** Write a real-life problem that could be solved by finding the volume of a prism. Then solve.

24. Popcorn tins are stacked in a display so that there are 12 tins in the bottom row. There are 10 tins in the next row, and 8 tins in the row above that. There are five rows of tins. If the pattern continues, how many popcorn tins are there in all?

A. 22   **C.** 40

B. 30   **D.** 42

25. [THINK SOLVE EXPLAIN] **SHORT RESPONSE** Find the volume in cubic meters of a cube with the dimension shown.
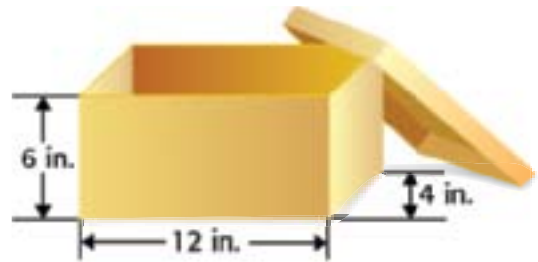
4 m
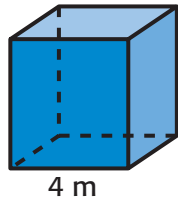
26. What is the volume of the rectangular prism shown below?

5 cm
3 cm
7 cm
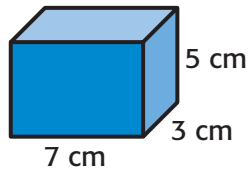
F. 88 cm^3 **H.** 120 cm^3

G. 105 cm^3 **I.** 142 cm^3

27. Shawn keeps his photos in a box like the one shown.

6 in.
4 in.
12 in.

What is the volume in cubic inches of the box?

A. 22

B. 72

C. 288

D. 300

28. [THINK SOLVE EXPLAIN] **SHORT RESPONSE** A rectangular prism made of 1-inch cubes is shown below.
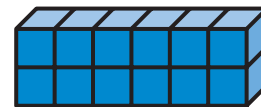
What is the volume of the prism?

Spiral Review

29. A box of crayons has a length of 9 inches, a width of 4 inches, and a height of 6 inches. What is the surface area of the box of crayons? **(Lesson 2B)**

30. What kind of three-dimensional shape is shown? **(Lesson 1B)**