8 Surface Area and Volume

Common Core Progression

4th Grade

- Find the areas of rectangles with whole number side lengths.
- Classify two-dimensional figures using angles and parallel and perpendicular lines.
- Draw line segments, angles, parallel lines, and perpendicular lines.

5th Grade

- Find the areas of rectangles with fractional side lengths.
- Classify two-dimensional figures into categories based on properties.
- Understand volume, and measure it by counting unit cubes.
- Find the volumes of rectangular prisms using the formula.

6th Grade

- Find areas of triangles, special quadrilaterals, and polygons.
- Use nets made up of rectangles and triangles to find surface areas.
- Find the volumes of prisms with fractional edge lengths.

Chapter Summary

Section	Common Core State Standard	
8.1	Learning	6.G.4
8.2	Learning	6.G.4
8.3	Learning	6.G.4 ★
8.4	Learning	6.G.2 ★
★ Teaching is complete. Standard can be assessed.		

Pacing Guide for Chapter 8

Chapter Opener	1 Day
Section 1	
Activity	1 Day
Lesson	1 Day
Section 2	
Activity	1 Day
Lesson	1 Day
Study Help / Quiz	1 Day
Section 3	
Activity	1 Day
Lesson	1 Day
Section 4	
Activity	1 Day
Lesson	1 Day
Chapter Review/ Chapter Tests	2 Days
Total Chapter 8	12 Days
Year-to-Date	127 Days

Technology for the Teacher

BigIdeasMath.com
Chapter at a Glance
Complete Materials List
Parent Letters: English and Spanish

Common Core State Standards

5.G.4 Classify two-dimensional figures in a hierarchy based on properties.
5.MD.5a Find the volume of a right rectangular prism with whole-number side lengths by packing it with unit cubes, and show that the volume is the same as would be found by multiplying the edge lengths, equivalently by multiplying the height by the area of the base. Represent threefold whole-number products as volumes, e.g., to represent the associative property of multiplication.

Additional Topics for Review

- Areas of Rectangles and Triangles
- Operations with Fractions
- Operations with Decimals

Try It Yourself

1. square
2. rectangle
3. trapezoid
4. 90 cubic units
5. 120 cubic units
6. 96 cubic units

Record and Practice Journal Fair Game Review

1. trapezoid
2. rectangle
3. square
4. equilateral triangle
5. square
6. 504 cubic units
7. 160 cubic units
8. 224 cubic units
9. 60 cubic units
10. 66 cubic units
11. 126 cubic units

Math Background Notes

Vocabulary Review

- Rectangle
- Square
- Parallelogram
- Right Angle
- Isosceles Triangle
- Equilateral Triangle
- Cubic Units

Classifying Figures

- Students have been defining and identifying plane figures since Grade 4.
- Review with students the marks indicating congruent segment lengths, parallel segments, and right angles.
- You may want to review the different types of triangles: right, acute, obtuse, equilateral, isosceles, and scalene.
- A flow chart is a great way to review classifying quadrilaterals.
- Students should be familiar with area formulas for squares, rectangles, and triangles.

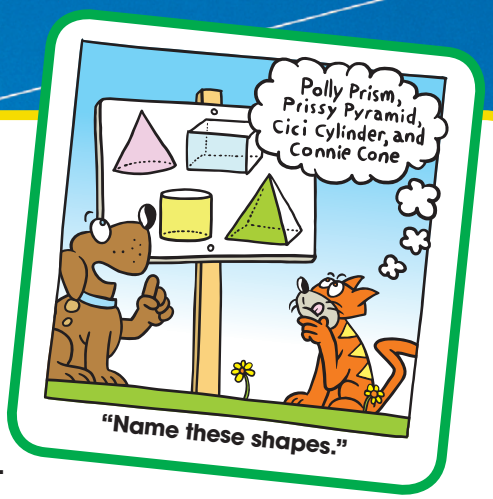
Finding Volumes of Rectangular Prisms

- Students should have a sense that volume is a *filling process* and that it can be found by stacking equal layers on top of one another.
- In Example 3, the area of the base is 28 square units, and the height of the prism is 5 units.
- **Connection:** Students can memorize formulas and have little understanding of why the formula makes sense. It is important that students see that all volume formulas are similar. The volume is found by finding the area of the base and then multiplying by the number of layers.
- You may want to review units with students. A complete answer will include a numeric solution and the correct units. Remind students that area is always measured in square units, and volume is always measured in cubic units.

Reteaching and Enrichment Strategies

If students need help. . .	If students got it. . .
Record and Practice Journal • Fair Game Review Skills Review Handbook Lesson Tutorials	Game Closet at *BigIdeasMath.com* Start the next section

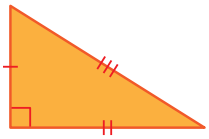
What You Learned Before



Classifying Figures

Example 1

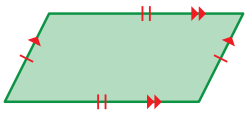
Identify the figure.



∴ Because the figure has a right angle and three sides of different lengths, it is a right scalene triangle.

Example 2

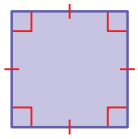
Identify the figure.

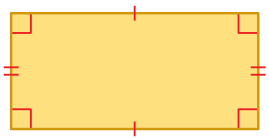


∴ Because the figure is a quadrilateral with opposite sides that are parallel, it is a parallelogram.

Try It Yourself

Identify the figure.

1. 

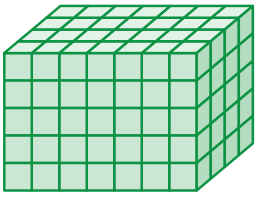
2. 

3. 

Finding Volumes of Rectangular Prisms

Example 3

Find the volume of the rectangular prism.



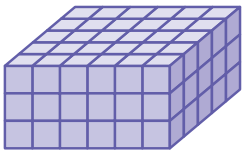
There are $4 \times 7 = 28$ unit cubes in each layer.

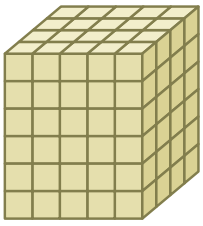
Because there are 5 layers, there are $5 \times 28 = 140$ unit cubes in the prism.

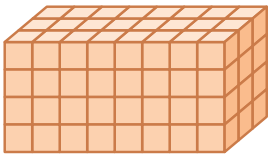
∴ So, the volume is 140 cubic units.

Try It Yourself

Find the volume of the rectangular prism.

4. 

5. 

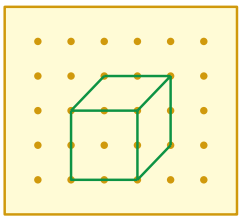
6. 

8.1 Three-Dimensional Figures

Essential Question How can you draw three-dimensional figures?

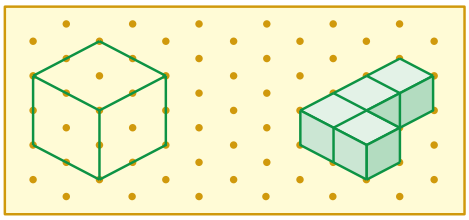
Dot paper can help you draw three-dimensional figures, or *solids*.

Square Dot Paper



Face-On view

Isometric Dot Paper

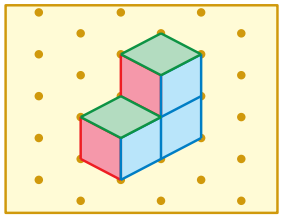


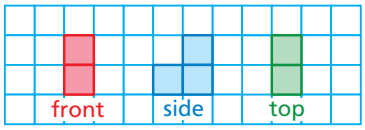
Corner view

1 ACTIVITY: Drawing Views of a Solid

Work with a partner. Draw the front, side, and top views of each stack of cubes. Then find the number of cubes in the stack.

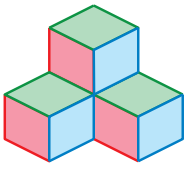
a. Sample:



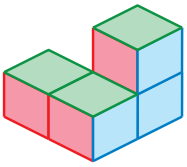


Number of cubes: 3

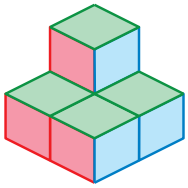
b.



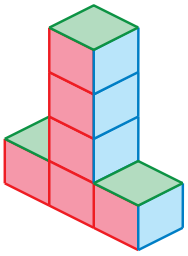
c.



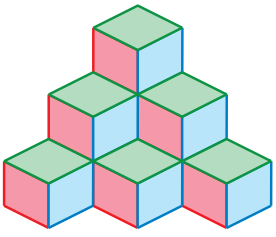
d.



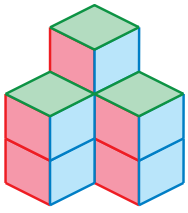
e.



f.



g.



Geometry

In this lesson, you will

- draw three-dimensional figures.
- find the number of faces, edges, and vertices of solids.

Laurie's Notes

Introduction

Standards for Mathematical Practice

- **MP5 Use Appropriate Tools Strategically:** As students are developing their spatial and visual skills, having cubes to hold and view is very helpful. The samples in the book are two-dimensional representations of three-dimensional figures. Manipulating and viewing actual cubes is a helpful tool for many students.

Motivate

- Place a cube-shaped tissue box on a desk. Ask students to describe what they see when standing directly in front of the cube (front view), to the side of the cube (side view), and looking down on the cube (top view).
- Now place a rectangular prism (a shoe box) on the same surface. Describe all three views.
- Place a cube on top of a rectangular prism creating a solid that might be similar to the one shown in part (a) of Activity 1.
- Describe all three views. Students are challenged to ignore the difference in depth when describing a solid from one of the view points. They should focus on the surface that they see, not the depth of the solid. This can often be confusing to students.

Activity Notes

Activity 1

- **MP5:** If enough cubes are available, give each pair of students 10 cubes to create the models on their desks or tables. To see each view, the students need to be at "eye level" with the solid.
- **Teaching Tip:** Another way to help students think about the top view is to ask them, "If you want to paint the top, what shapes would you paint?" Two squares would be painted. Repeat this strategy for each view.
- Discuss volume. How many cubes are necessary to build the figure? Students are often confused by the cubes that are not visible in the picture. Explain that parts (b), (d), (f), and (g) would fit into the corner of a room. There are cubes behind cubes that are supporting the top cubes.
- **Scaffolding:** You may want half the class to work on parts (b), (d), and (f), while the other half works on parts (c), (e), and (g).
- Generally, it is the side view that is often challenging to draw.
- Check to see if students understand that the volume is the same number of cubes as the number of cubes used to build the figure.

Common Core State Standards

6.G.4 Represent three-dimensional figures . . ..

Previous Learning

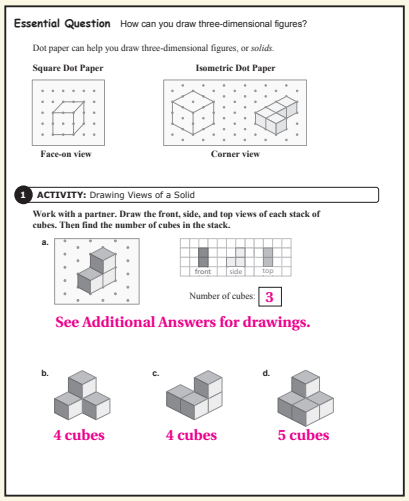
Students should know the vocabulary of prisms.

Technology for the Teacher

Dynamic Classroom

Lesson Plans
Complete Materials List

8.1 Record and Practice Journal



Essential Question How can you draw three-dimensional figures?

Dot paper can help you draw three-dimensional figures, or *solids*.

Square Dot Paper — Face-on view

Isometric Dot Paper — Corner view

1 ACTIVITY: Drawing Views of a Solid

Work with a partner. Draw the front, side, and top views of each stack of cubes. Then find the number of cubes in the stack.

a. front | side | top

Number of cubes: 3

See Additional Answers for drawings.

b. 4 cubes

c. 4 cubes

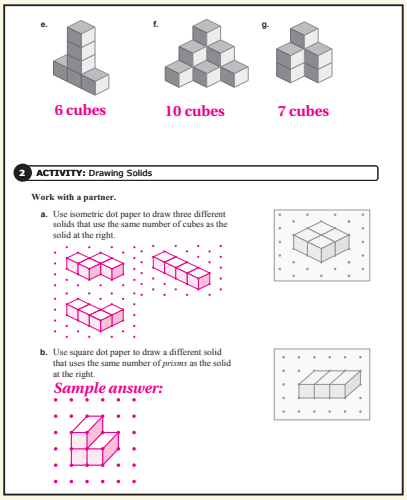
d. 5 cubes

Differentiated Instruction

Kinesthetic

Provide building blocks or cubes for students to use. Students may work in pairs. Each student builds a solid out of sight of his/her partner and draws front, top, and side views. Students meet at a neutral site and trade drawings. At the building site, the student builds the solid shown in the drawing. Students get together to compare their drawings and models.

8.1 Record and Practice Journal



e. 6 cubes

f. 10 cubes

g. 7 cubes

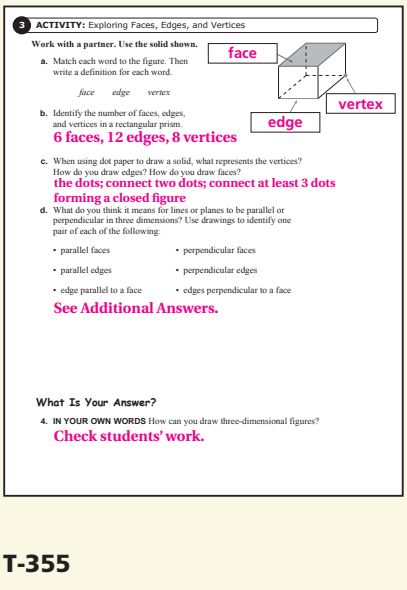
2 ACTIVITY: Drawing Solids

Work with a partner.

a. Use isometric dot paper to draw three different solids that use the same number of cubes as the solid at the right.

b. Use square dot paper to draw a different solid that uses the same number of *prisms* as the solid at the right.

Sample answer:



3 ACTIVITY: Exploring Faces, Edges, and Vertices

Work with a partner. Use the solid shown.

a. Match each word to the figure. Then write a definition for each word.

face *edge* *vertex*

face

vertex

edge

b. Identify the number of faces, edges, and vertices in a rectangular prism.

6 faces, 12 edges, 8 vertices

c. When using dot paper to draw a solid, what represents the vertices? How do you draw edges? How do you draw faces?

the dots; connect two dots; connect at least 3 dots forming a closed figure

d. What do you think it means for lines or planes to be parallel or perpendicular in three dimensions? Use drawings to identify one pair of each of the following.

- parallel faces
- perpendicular faces
- parallel edges
- perpendicular edges
- edge parallel to a face
- edges perpendicular to a face

See Additional Answers.

What Is Your Answer?

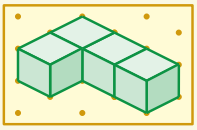
4. **IN YOUR OWN WORDS** How can you draw three-dimensional figures?

Check students' work.

Laurie's Notes

Activity 2

- If time is a concern, you might elect to skip Activity 2.
- Students will use 4 cubes and arrange them to form three different solids.
- Help students understand that the orientation of the solid does not make it different, meaning 4 horizontal cubes would be the same solid as 4 vertical cubes.
- Students may need help getting started with their sketches. Suggest that they refer back to the sample. If the front cube were moved to make a number 7, what would still be the same? What would be different?



- Students should be familiar with the word *prism* from prior grades.
- In part (b), students will use 3 rectangular prisms. Primary teachers may have colored rods or similar prisms for your students to use in this activity.
- Ask volunteers to share their solutions.

Activity 3

- If students are stuck on a vocabulary word, they should ask their partners or look the word up in a glossary or a math dictionary.
- Before students go too far, ensure that they have correctly identified the vertex, edge, and face of the prism shown.
- In part (d), make sure they answer the first question for all 6 combinations: (line and line, plane and plane, plane and line) and (parallel, perpendicular)
- It is essential for students to think of an edge as a part of a line and a face as part of a plane.
- Students will likely say that lines are parallel in three dimensions if they do not intersect. However, they must not intersect *and* lie in the same plane. Allow them to struggle with this and be incorrect at first. After making this distinction, tell them that lines that do not intersect in three dimensions and are in different planes are called *skew lines*. You could now ask them to identify a pair of skew edges if desired.
- To get students away from only considering planes in which the faces of the prism lie, ask if the "top" edge of one of the "sides" is parallel to the "bottom" edge of the opposite side. Because a plane is not drawn through those lines (edges), they may think they are skew. Students should be able to visualize a plane crossing through the prism diagonally containing both lines. This is an important preview of CCSS 7.G.3, slicing three-dimensional figures with planes.

What Is Your Answer?

- For Question 4, students should refer back to their sketches from the first activity.

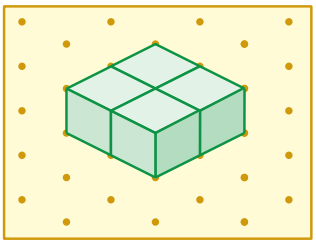
Closure

- How did the three views of a solid help you determine the number of cubes in the stack? Answers will vary.

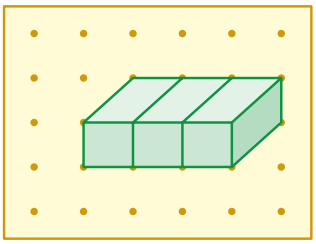
2 ACTIVITY: Drawing Solids

Work with a partner.

a. Use isometric dot paper to draw three different solids that use the same number of cubes as the solid at the right.

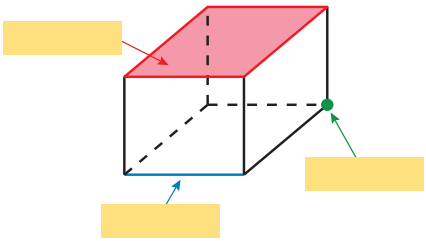


b. Use square dot paper to draw a different solid that uses the same number of *prisms* as the solid at the right.



3 ACTIVITY: Exploring Faces, Edges, and Vertices

Work with a partner. Use the solid shown.



a. Match each word to the figure. Then write a definition for each word.

face *edge* *vertex*

b. Identify the number of faces, edges, and vertices in a rectangular prism.

c. When using dot paper to draw a solid, what represents the vertices? How do you draw edges? How do you draw faces?

d. What do you think it means for lines or planes to be parallel or perpendicular in three dimensions? Use drawings to identify one pair of each of the following:

- parallel faces
- parallel edges
- edge parallel to a face
- perpendicular faces
- perpendicular edges
- edge perpendicular to a face

Math Practice

View as Components

What are the different parts of a three-dimensional object? How can dot paper help you draw the parts of the object?

What Is Your Answer?

4. IN YOUR OWN WORDS How can you draw three-dimensional figures?

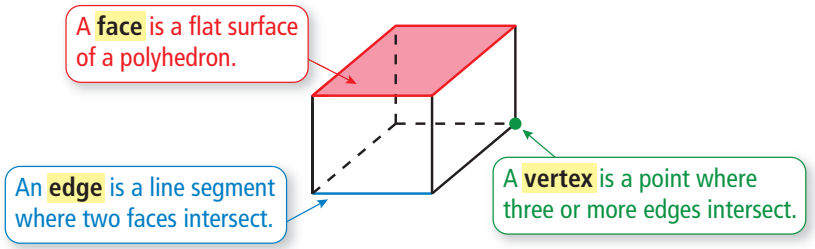
Practice Use what you learned about three-dimensional figures to complete Exercises 7–9 on page 358.

8.1 Lesson

Check It Out
Lesson Tutorials
BigIdeasMath.com

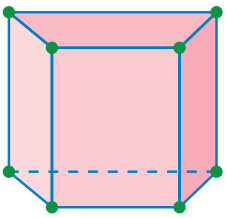
Key Vocabulary
solid, *p. 356*
polyhedron, *p. 356*
face, *p. 356*
edge, *p. 356*
vertex, *p. 356*
prism, *p. 356*
pyramid, *p. 356*

A **solid** is a three-dimensional figure that encloses a space. A **polyhedron** is a solid whose *faces* are all polygons.



EXAMPLE 1 Finding the Number of Faces, Edges, and Vertices

Find the number of faces, edges, and vertices of the solid.



The solid has 1 face on the bottom, 1 face on the top, and 4 faces on the sides.

The faces intersect at 12 different line segments.

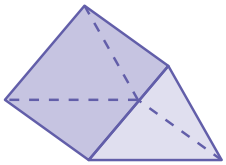
The edges intersect at 8 different points.

So, the solid has 6 faces, 12 edges, and 8 vertices.

On Your Own

Now You're Ready
Exercises 10–12

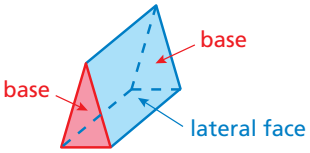
1. Find the number of faces, edges, and vertices of the solid.



Key Ideas

Prisms

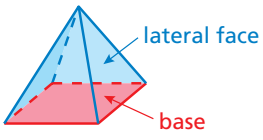
A **prism** is a polyhedron that has two parallel, identical *bases*. The *lateral faces* are parallelograms.



Triangular Prism

Pyramids

A **pyramid** is a polyhedron that has one base. The lateral faces are triangles.



Rectangular Pyramid

The shape of the base tells the name of the prism or the pyramid.

Multi-Language Glossary at BigIdeasMath.com

Laurie's Notes

Introduction

Connect

- **Yesterday:** Students explored sketching solids on isometric dot paper. (MP5)
- **Today:** Students will be introduced to the vocabulary of prisms and pyramids and asked to sketch several solids.

Motivate

- Collect and display prisms and pyramids from school or home.
- Ask a volunteer to select one solid and describe it using mathematical vocabulary. You want students to say "prism" instead of "box of cereal." Besides naming the object, they should identify its features or attributes. They may say that the prism has 6 rectangular sides.
- ? "Are there any other solids in the collection that share the same features or attributes?" Listen for what attribute(s) the second solid shares with the first.
- Repeat this process for several solids.

Lesson Notes

Example 1

- ? "How many faces are there, and how would you describe their locations?" 6; top, bottom, 4 around the sides
- ? "How many edges are there, and how would you describe their locations? 12; 4 around the top, 4 around the bottom, and 4 vertical on the sides
- ? "How many vertices are there, and how would you describe their locations? 8; 4 on the top and 4 on the bottom
- **MP7 Look for and Make Use of Structure:** Repeat the example using prisms with different bases. Students should recognize that the number of faces will always be 2 more than the number of edges on the base. The number of vertices will be twice the number of edges on the base. The number of edges will always be 3 times the number of edges on the base.

On Your Own

- **Neighbor Check:** Have students work independently and then have their neighbors check their work. Have students discuss any discrepancies.

Key Ideas

- The point of the vocabulary is not to memorize definitions, but to have a sense as to the attributes of the solid. This will help in generalizing surface area and volume formulas later.
- Mention to students that prisms and pyramids have a qualifying name, given the type of base. A triangular prism has two bases that are triangles.
- **Common Error:** Students often think that the face that is "on the bottom" is the base. The solid does not need to be oriented so that it is resting on a base. Demonstrate this with several solids.
- It may be helpful to use vocabulary, such as vertex (vertices) and edge.

Goal Today's lesson is sketching and learning the vocabulary of **prisms** and **pyramids**.

Technology for the Teacher

Dynamic Classroom

Lesson Tutorials
Lesson Plans
Answer Presentation Tool

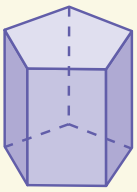
English Language Learners

Vocabulary

By this time, students should be able to tell the difference between a prism and a pyramid. Discuss the terms *base* and *face*. Explain that all the surfaces of prisms and pyramids are *faces*. Prisms have two bases that are congruent polygons and that are parallel to each other. Pyramids have only one face that is called the base.

Extra Example 1

Find the number of faces, edges, and vertices of the solid.



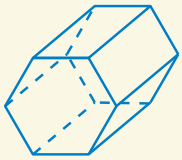
7 faces, 15 edges, 10 vertices

On Your Own

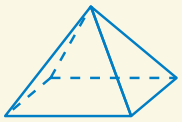
1. 5 faces, 9 edges, 6 vertices

Extra Example 2

a. Draw a hexagonal prism.

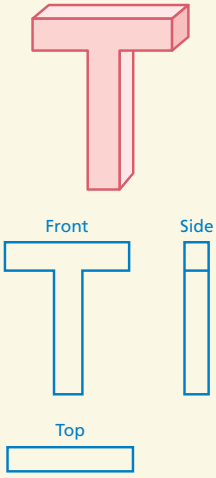


b. Draw a rectangular pyramid.



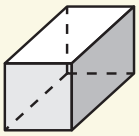
Extra Example 3

Draw the front, side, and top views of the solid.

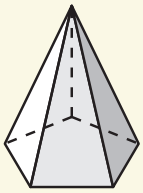


On Your Own

2.



3.



4–5. See Additional Answers.

Laurie's Notes

Example 2

- Demonstrate how to sketch a triangular pyramid.
- Drawings of objects may differ based on perspective. For instance, the point in step 1 could be placed below the triangle, or different lines in step 3 could be dashed. Each would offer a different perspective of the same object.

Example 3

- This example connects to yesterday's activity.
- Remind students that they need to take a *bird's eye view* in each of the three directions.

On Your Own

- Ask volunteers to draw their sketches at the board.

Closure

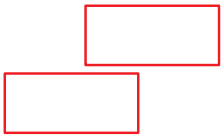
- Sketch a rectangular prism. Draw the front, side, and top views.

EXAMPLE 2 Drawing Solids

a. Draw a rectangular prism.

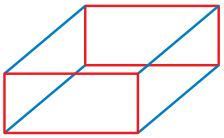
Step 1:

Draw identical rectangular bases.



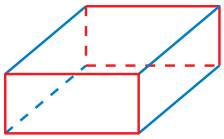
Step 2:

Connect corresponding vertices.



Step 3:

Change any *hidden* lines to dashed lines.



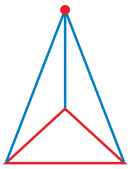
b. Draw a triangular pyramid.

Step 1:

Draw a triangular base and a point.

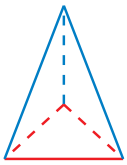
Step 2:

Connect the vertices of the triangle to the point.

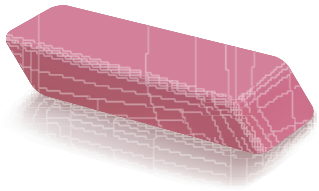


Step 3:

Change any *hidden* lines to dashed lines.



EXAMPLE 3 Drawing Views of a Solid



Draw the front, side, and top views of the eraser.

The front view is a parallelogram.

The side view is a rectangle.

The top view is a rectangle.

On Your Own

Now You're Ready
Exercises 13–22

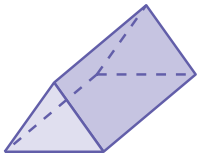
Draw the solid.

2. square prism

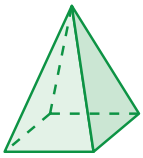
3. pentagonal pyramid

Draw the front, side, and top views of the solid.

4.



5.



8.1 Exercises

Check It Out
Help with Homework
BigIdeasMath.com

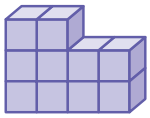
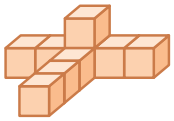
Vocabulary and Concept Check

LOGIC **Decide whether the statement is *true* or *false*. If false, explain your reasoning.**

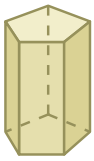
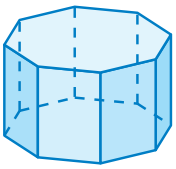
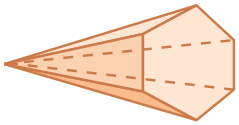
1. A triangular prism has three triangular faces.
2. A triangular prism has three rectangular faces.
3. A rectangular pyramid has one rectangular face.
4. A rectangular pyramid has three triangular faces.
5. All of the edges of a rectangular prism are parallel.
6. None of the edges of a rectangular pyramid are parallel.

Practice and Problem Solving

Draw the front, side, and top views of the stack of cubes. Then find the number of cubes in the stack.

7. 
8. 
9. 

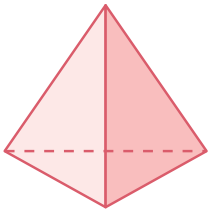
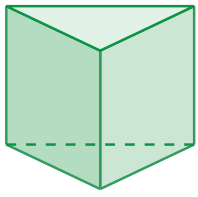
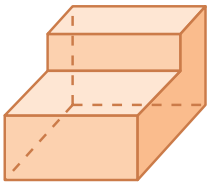
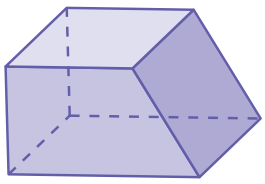
Find the number of faces, edges, and vertices of the solid.

1 10. 
11. 
12. 

Draw the solid.

2 13. triangular prism
14. pentagonal prism
15. rectangular pyramid
16. hexagonal pyramid

Draw the front, side, and top views of the solid.

3 17. 
18. 
19. 
20. 
21. 
22. 

Assignment Guide and Homework Check

Level	Day 1 Activity Assignment	Day 2 Lesson Assignment	Homework Check
Basic	7–9, 30–33	1–6, 11–25 odd	11, 13, 21, 23
Average	7–9, 30–33	1–6, 11–23 odd, 24–26	11, 13, 21, 23, 26
Advanced	7–9, 30–33	1–6, 10–28 even	12, 14, 18, 26, 28

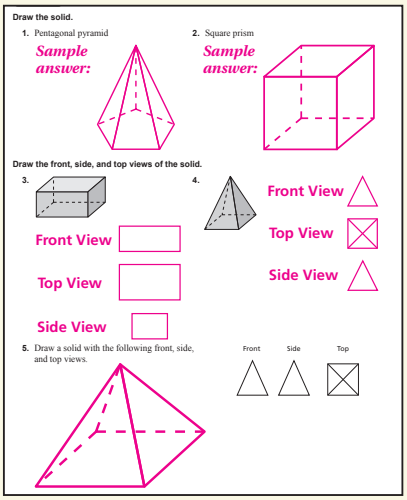
For Your Information

- **Exercise 23** The pyramid was built 18 B.C.–12 B.C. as a tomb for a Roman magistrate. It measures 100 Roman feet (22 meters) square at the base and is 125 Roman feet (27 meters) high.

Common Errors

- **Exercises 13–16** Students may mix up the different types of solids. Remind them of the definition of each solid and give a few real-life examples of each solid.
- **Exercises 17–22** Students may have difficulty visualizing the front, side, and top views of the solid. Create paper objects for those who are struggling to draw the different sides of the solid.
- **Exercises 25 and 26** Students may not be able to see how the shapes go together. Have them cut out pieces of paper or use blocks to model the solid.

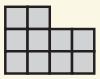
8.1 Record and Practice Journal

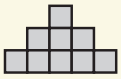


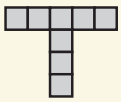
Vocabulary and Concept Check

1. false; It has two triangular faces.
2. true
3. true
4. false; It has four triangular faces.
5. false; Some are perpendicular and some are neither (skew).
6. false; Opposite edges of the base are parallel.

Practice and Problem Solving

7. front: 
side:  top: 
10 cubes

8. front: 
side:  top: 
9 cubes

9. front: 
side: 
top: 
9 cubes

10. 7 faces, 15 edges, and 10 vertices

11. 10 faces, 24 edges, and 16 vertices

12. 7 faces, 12 edges, and 7 vertices

13–26. See Additional Answers.

Practice and Problem Solving

27. *Answer should include, but is not limited to*: an original drawing of a house; a description of any solids that make up any part of the house

28. See *Taking Math Deeper*.

29. See Additional Answers.

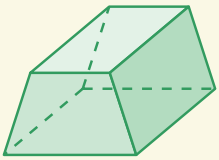
Fair Game Review

30. 28 m^2 **31.** 12 cm^2

32. 15 ft^2 **33.** D

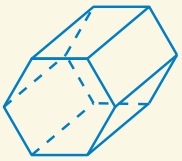
Mini-Assessment

1. Find the number of faces, edges, and vertices of the solid.

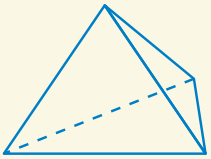


6 faces, 12 edges, 8 vertices

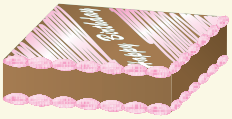
2. Draw a hexagonal prism.



3. Draw a triangular pyramid.



4. You and a friend attend a birthday party. Draw the front, side, and top views of the birthday cake.

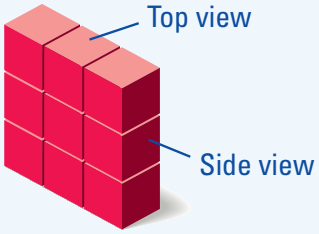


Taking Math Deeper

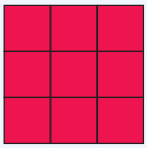
Exercise 28

This type of problem begs to be touched, felt, and seen. Give students 9 cubes and ask them to construct different solids that have the given top and side views.

1 Help me see it.
Build different solids out of 9 cubes.

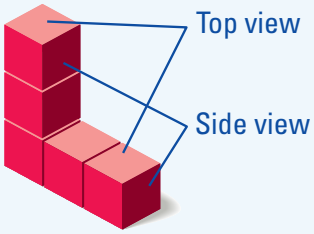


c. Front view

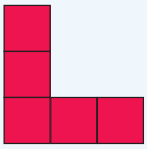


a. The greatest number of cubes is 9.

2 Here is a different one.

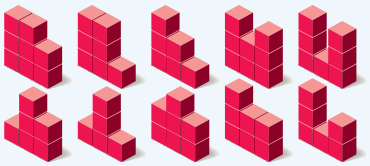


c. Front view



b. The least number of cubes is 5.

3 Here are the other possibilities (does not include reflections).



Reteaching and Enrichment Strategies

If students need help. . .	If students got it. . .
Resources by Chapter • Practice A and Practice B • Puzzle Time Record and Practice Journal Practice Differentiating the Lesson Lesson Tutorials Skills Review Handbook	Resources by Chapter • Enrichment and Extension • Technology Connection Start the next section

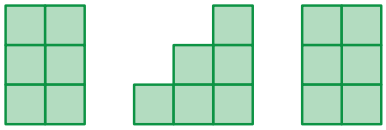
23. **PYRAMID ARENA** The Pyramid of Caius Cestius in Rome, Italy, is in the shape of a square pyramid. Draw a sketch of the pyramid.

24. **RESEARCH** Use the Internet to find a picture of the Washington Monument. Describe its shape.

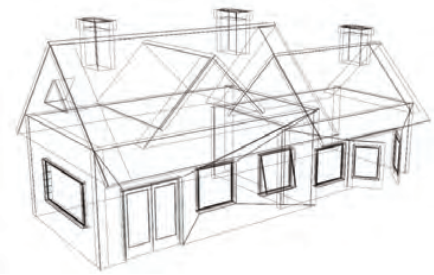
Draw a solid with the following front, side, and top views.

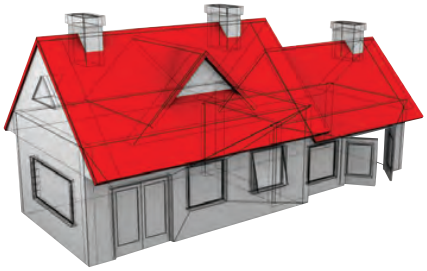
25.

26.

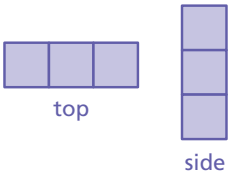


27. **PROJECT** Design and draw a house. Name the different solids that you can use to make a model of the house.





28. **REASONING** Two of the three views of a solid are shown.



a. What is the greatest number of unit cubes in the solid?

b. What is the least number of unit cubes in the solid?

c. Draw the front views of both solids in parts (a) and (b).

29. Reasoning Draw two different solids with five faces.

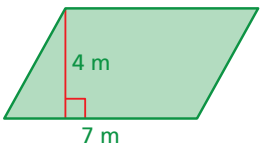
a. Write the number of vertices and edges for each solid.

b. Explain how knowing the numbers of edges and vertices helps you draw a three-dimensional figure.

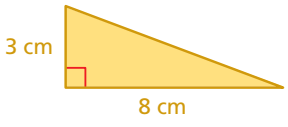
Fair Game Review What you learned in previous grades & lessons

Find the area of the figure. *(Section 4.1, Section 4.2, and Section 4.3)*

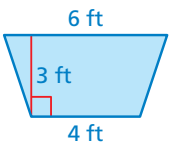
30.



31.



32.



33. **MULTIPLE CHOICE** Which statement is true when $x = -2$ and $y = |-2|$? *(Section 6.4)*

Ⓐ $x = y$ Ⓑ $y < 0$ Ⓒ $x > y$ Ⓓ $y > x$

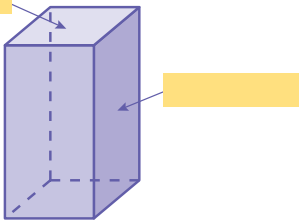
8.2 Surface Areas of Prisms

Essential Question How can you find the area of the entire surface of a prism?

1 ACTIVITY: Identifying Prisms

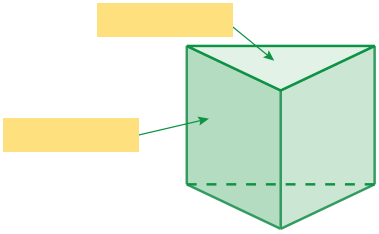
Work with a partner. Label one of the faces as a "base" and the other as a "lateral face." Use the shape of the base to identify the prism.

a.



_____ **Prism**

b.



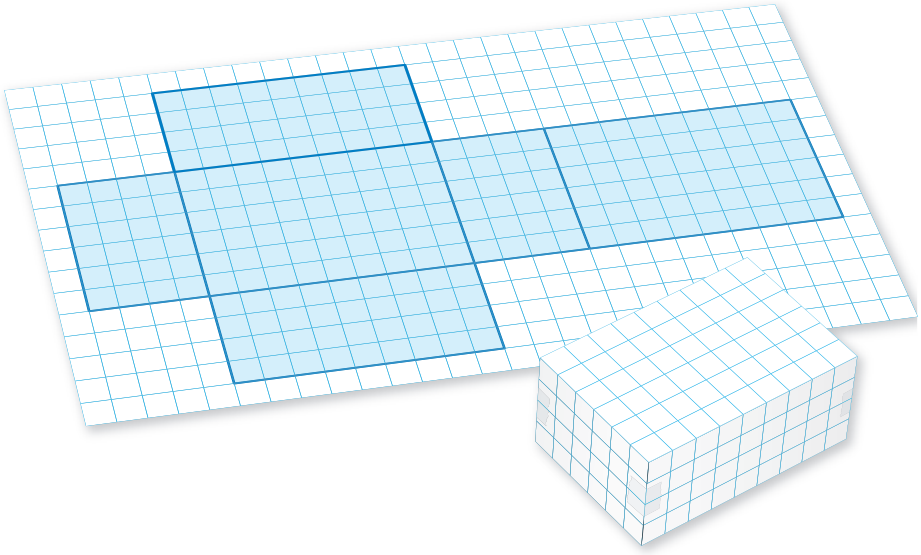
_____ **Prism**

2 ACTIVITY: Using Grid Paper to Construct a Prism

Work with a partner.

a. Copy the figure shown below onto grid paper.

b. Cut out the figure and fold it to form a prism. What type of prism does it form?



Geometry

In this lesson, you will

- use nets to represent prisms.
- find the surface area of prisms.
- solve real-life problems.

Laurie's Notes

Introduction

Standards for Mathematical Practice

- **MP8 Look for and Express Regularity in Repeated Reasoning:** Students will be finding the area of the entire surface of several prisms. In doing so they may discover an efficient method. For instance, a rectangular prism has 3 pairs of congruent faces. Finding the area of one from each pair and then doubling is more efficient than doing six computations.

Motivate

- Hold up two different rectangular prisms made of cardboard, one clearly larger than the other.

? "Which box used more cardboard when it was made? Explain how you know." Listen for an explanation that refers to finding the area of each face and adding up all of the areas and then repeating that process for the second prism.

Discuss

- Review the vocabulary of prisms (base, lateral face).
- Point out that prisms are named by the shapes of their bases. For instance, a triangular prism has triangular bases.
- Note: The term *lateral face* is used in the activity. *Lateral surface area* is taught in Grade 7.

Activity Notes

Activity 1

- Students should work with their partners to identify the bases and lateral faces of each prism.
- In this activity, students can label the faces however they want in part (a). Any pair of opposite sides can be considered the bases. Explore this with students. Note that it is traditional to consider the *top and bottom* faces of a rectangular prism as the bases.
- Check to see that the prisms are named correctly.

Activity 2

- **Teaching Tip:** To avoid having scraps of paper on the floor, recycle plastic bags and tape them to desks around the room. There should be a bag close enough to each group so that there is no excuse for leaving a mess.
- In order to copy the figure correctly, students will need to determine the dimensions of each face, or at least do some counting. This process will be helpful in developing the concept of surface area of a solid.
- If time permits, ask students questions about the prism they folded. How many vertices, faces, and edges does the prism have? Which faces are parallel? Which faces are perpendicular?

Common Core State Standards

6.G.4 Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.

Previous Learning

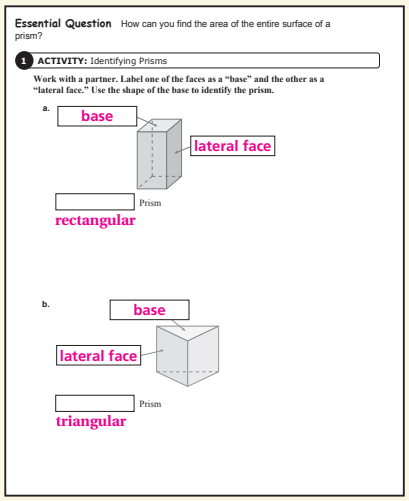
Students need to be familiar with prisms.

Technology for the Teacher

Dynamic Classroom

Lesson Plans
Complete Materials List

8.2 Record and Practice Journal


Essential Question How can you find the area of the entire surface of a prism?

1 ACTIVITY: Identifying Prisms

Work with a partner. Label one of the faces as a "base" and the other as a "lateral face." Use the shape of the base to identify the prism.

a. base, lateral face

Prism
rectangular

b. base, lateral face

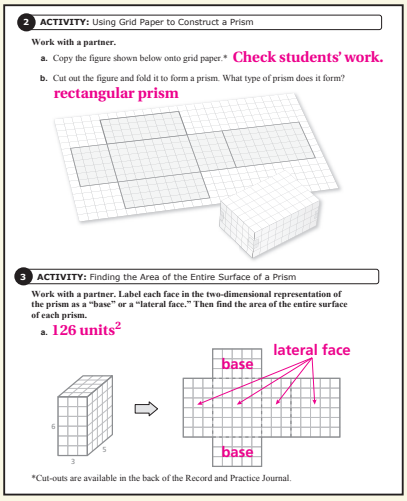
Prism
triangular

English Language Learners

Vocabulary

English learners may be familiar with the word *net* in everyday context. In finance, the net profit describes the bottom line of a financial transaction. In fishing, a net is a collection of knotted strings used to catch fish. In mathematical context, *net* or *geometric net* is used to mean the two-dimensional representation of a solid object.

8.2 Record and Practice Journal



2 ACTIVITY: Using Grid Paper to Construct a Prism

Work with a partner.

a. Copy the figure shown below onto grid paper.* **Check students' work.**

b. Cut out the figure and fold it to form a prism. What type of prism does it form?

rectangular prism

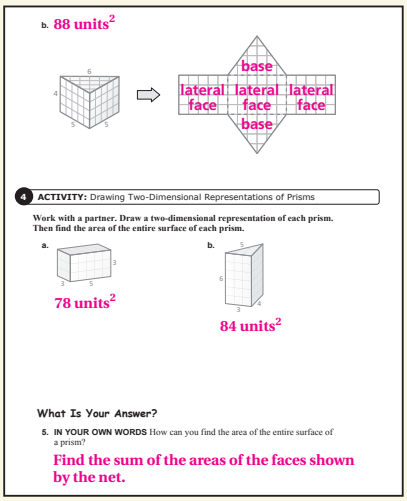
3 ACTIVITY: Finding the Area of the Entire Surface of a Prism

Work with a partner. Label each face in the two-dimensional representation of the prism as a "base" or a "lateral face." Then find the area of the entire surface of each prism.

a. **126 units²**

base, lateral face, base

*Cut-outs are available in the back of the Record and Practice Journal.



b. **88 units²**

base, lateral face, lateral face, lateral face, base

4 ACTIVITY: Drawing Two-Dimensional Representations of Prisms

Work with a partner. Draw a two-dimensional representation of each prism. Then find the area of the entire surface of each prism.

a. **78 units²**

b. **84 units²**

What Is Your Answer?

5. **IN YOUR OWN WORDS** How can you find the area of the entire surface of a prism?

Find the sum of the areas of the faces shown by the net.

Laurie's Notes

Activity 3

- In this activity, students can label the faces however they want in part (a). Any pair of opposite sides can be considered the bases. Explore this with students. Note that it is traditional to consider the *top and bottom* faces of a rectangular prism as the bases.
- Instead of cutting and folding up a prism as they did in Activity 2, this activity reverses that process. Students have to think about how the prism is unfolded to make the template shown.
- Students may recognize that part (a) is the prism (net) from Activity 2. They have a model of the prism in front of them that they can relate to for this activity.
- **Teaching Tip:** When working through the activity, refer to the faces as the *surface*, so they are finding the area of the surface. This leads into the definition of *surface area* in the lesson.
- **MP3 Construct Viable Arguments and Critique the Reasoning of Others** and **MP8:** When students have finished, ask volunteers to share how they found the area of the entire surface of the prism. There will be different strategies so expect all students to listen carefully to the process. Does the process described for part (a) work for part (b)?
- **Big Idea:** The grid shown on the surface of the prisms helps students focus on the idea of area. The square units are visible.

Activity 4

- **Scaffolding:** If time is a concern, have half of the class work on part (a) and the other half work on part (b).
- **Teaching Tip:** When working through the activity, refer to the faces as the *surface*, so they are finding the area of the surface. This leads into the definition of *surface area* in the lesson.
- These drawings can be challenging for some students. Going from the solid to the two-dimensional representation is different than the reverse. If students are having trouble, suggest that they begin with one face and sketch it. Then move to a second face that shares an edge with the first face. The two faces are either both lateral or one is a lateral face and the second is a base. Refer back to Activity 1 or 3 for help in thinking about where to draw the second face. Repeat this process for the remaining faces.
- There are different two-dimensional representations (nets) that can be drawn for each prism. Take time for students to investigate this.

What Is Your Answer?

- Listen for a process that describes finding the sum of the areas of all of the faces.

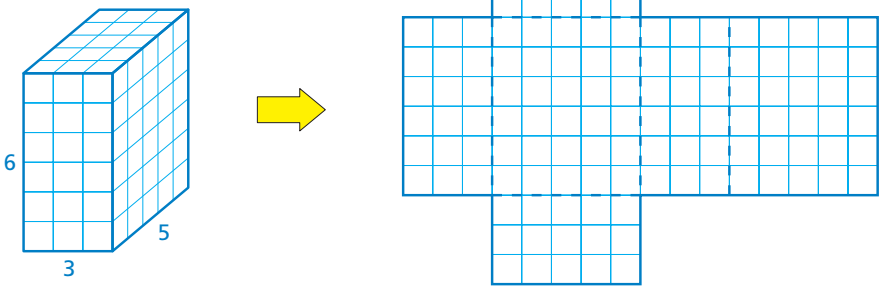
Closure

- **Writing Prompt:** To find the total area of all faces of a tissue box I would . . .
  Sum the areas of the six faces.

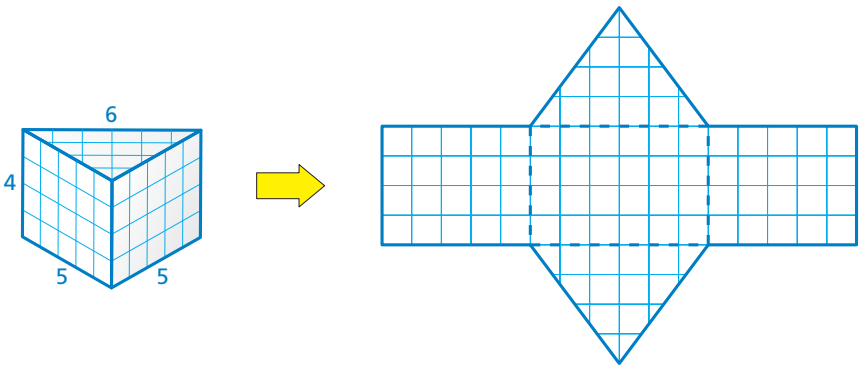
3 ACTIVITY: Finding the Area of the Entire Surface of a Prism

Work with a partner. Label each face in the two-dimensional representation of the prism as a "base" or a "lateral face." Then find the area of the entire surface of each prism.

a.



b.



Math Practice

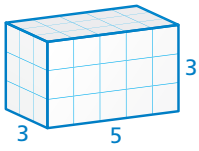
Repeat Calculations

When finding the areas of the faces, what calculations do you repeat?

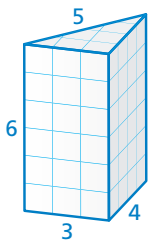
4 ACTIVITY: Drawing Two-Dimensional Representations of Prisms

Work with a partner. Draw a two-dimensional representation of each prism. Then find the area of the entire surface of each prism.

a.



b.



What Is Your Answer?

5. IN YOUR OWN WORDS How can you find the area of the entire surface of a prism?

Practice Use what you learned about the area of the entire surface of a prism to complete Exercises 3–5 on page 364.

8.2 Lesson

Check It Out
Lesson Tutorials
BigIdeasMath.com

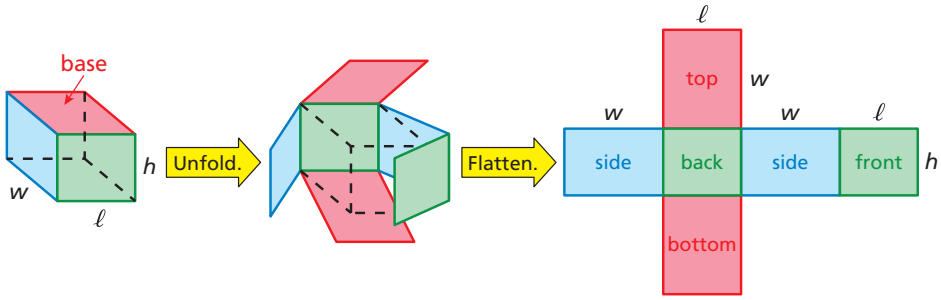
Key Vocabulary
surface area, *p. 362*
net, *p. 362*

The **surface area** of a solid is the sum of the areas of all of its faces. You can use a two-dimensional representation of a solid, called a **net**, to find the surface area of the solid. Surface area is measured in *square units*.

Key Idea

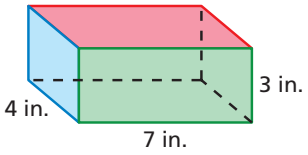
Net of a Rectangular Prism

A *rectangular prism* is a prism with rectangular bases.



EXAMPLE 1 Finding the Surface Area of a Rectangular Prism

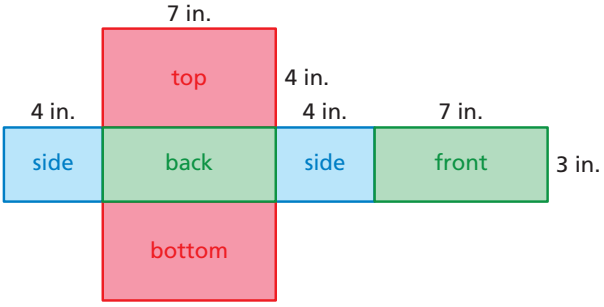
Find the surface area of the rectangular prism.



STEM VIDEO

Use a net to find the area of each face.

Top: $7 \cdot 4 = 28$
Bottom: $7 \cdot 4 = 28$
Front: $7 \cdot 3 = 21$
Back: $7 \cdot 3 = 21$
Side: $4 \cdot 3 = 12$
Side: $4 \cdot 3 = 12$



Find the sum of the areas of the faces.

$$\begin{aligned} \text{Surface Area} &= \text{Area of top} + \text{Area of bottom} + \text{Area of front} + \text{Area of back} + \text{Area of a side} + \text{Area of a side} \\ S &= 28 + 28 + 21 + 21 + 12 + 12 \\ &= 122 \end{aligned}$$

∴ So, the surface area is 122 square inches.

Multi-Language Glossary at BigIdeasMath.com

Laurie's Notes

Introduction

Connect

- **Yesterday:** Students worked with two-dimensional representations (nets) of prisms and found the area of each face. (MP3, MP8)
- **Today:** Students will use a net to find the surface area of a prism.

Motivate

- Have available cardboard prisms that have been folded.
- Holding the assembled solids, ask students to visualize and then describe the cardboard nets that result when the solids are "unfolded."
- Unfold one or more of the solids so that students can see the net of the prism.
- Explain the connection between the cardboard net and the surface area of the prism.

Lesson Notes

Discuss

- Define surface area and net.
- Remind students that square units are used to label surface area.

Key Idea

- Write the Key Idea.
- Refer to the physical models in the Motivate activity to describe a net for a rectangular prism.

Example 1

- Hold a cardboard box and ask, "How can you find the total amount of cardboard used to make this box?" Find the sum of the areas of the six faces.
- **MP8 Look for and Express Regularity in Repeated Reasoning:** Work through the example as shown. Students may find it easier to consider the three pairs of opposite faces instead of finding the area of each of the six faces separately.
- "What units are used to label surface area?" square units

Goal Today's lesson is finding **surface areas** of prisms using **nets**.

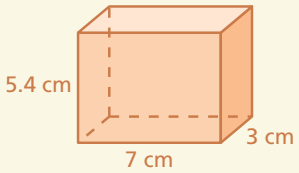
Technology for the Teacher

Dynamic Classroom

Lesson Tutorials
Lesson Plans
Answer Presentation Tool

Extra Example 1

Find the surface area of the rectangular prism.



150 cm^2

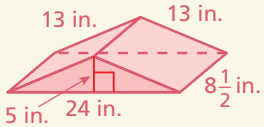
Differentiated Instruction

Visual

Use a rectangular box to demonstrate two ways of finding surface area. The first method is to find the area of each face and then add areas. The second method is to open the box into a net and find the area of the net. Students should see that the two methods have the same result.

Extra Example 2

Find the surface area of the triangular prism.



545 in.^{2}

On Your Own

1. 258 m^2
2. 180 in.^{2}
3. 286 ft^2
4. 60 yd^2
5. 420 m^2
6. 299.32 ft^2

Laurie's Notes

Key Idea

- Have a net available as a visual, whether it is a cardboard box or a triangular prism made from polygon frames.
- Discuss with students that a triangular prism has two opposite faces that are triangles, and the rest of the faces are rectangles.

Example 2

- Note that the net is a visual reminder to find the area of each face. Color-coding the faces helps students keep track of their work.
- "How many faces does a triangular prism have?" 5
- "How do you find the area of a triangle?" $A = \frac{1}{2}bh$
- Encourage students to write a verbal model for the surface area of the prism and then substitute the areas of the faces as they are computed.

On Your Own

- **MP6 Attend to Precision:** Students may forget to include the area of one or more of the faces when finding the surface area.
- Verify that fraction (Exercise 2) and decimal (Exercises 3 and 6) computations are done correctly.
- Exercise 4 involves a right triangle. Some students may need to be reminded that one side is the base and one side is the height.
- Exercise 6 includes decimal dimensions. Students may find it helpful to think of the area formula for triangles as $A = (0.5)bh$.

Closure

- Hold one of the items from the Motivate activity of today's lesson and ask students to find the surface area of the prism.

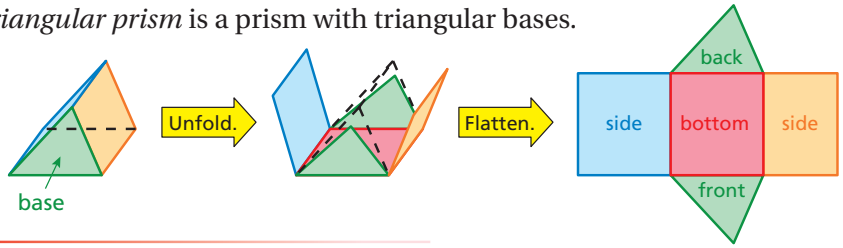
Key Idea

Remember

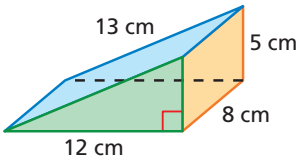
The area A of a triangle with base b and height h is $A = \frac{1}{2}bh$.

Net of a Triangular Prism

A *triangular prism* is a prism with triangular bases.



EXAMPLE 2 Finding the Surface Area of a Triangular Prism



Find the surface area of the triangular prism.

Use a net to find the area of each face.

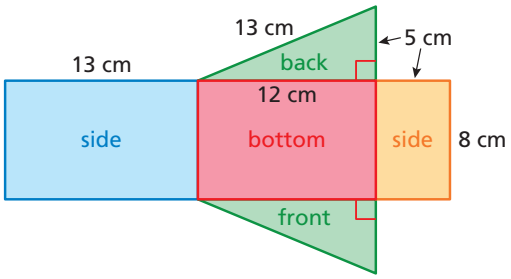
Bottom: $12 \cdot 8 = 96$

Front: $\frac{1}{2} \cdot 12 \cdot 5 = 30$

Back: $\frac{1}{2} \cdot 12 \cdot 5 = 30$

Side: $13 \cdot 8 = 104$

Side: $8 \cdot 5 = 40$



Find the sum of the areas of the faces.

$$\begin{array}{ccccccccccc} \text{Surface Area} & = & \text{Area of bottom} & + & \text{Area of front} & + & \text{Area of back} & + & \text{Area of a side} & + & \text{Area of a side} \\ S & = & 96 & + & 30 & + & 30 & + & 104 & + & 40 \end{array} \quad = 300$$

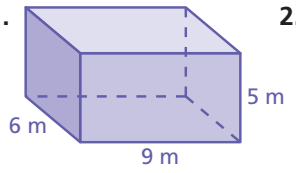
∴ So, the surface area is 300 square centimeters.

On Your Own

Now You're Ready
Exercises 6–11

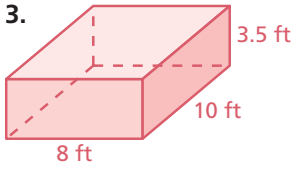
Find the surface area of the rectangular prism.

1.



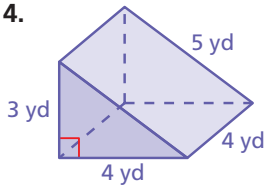
2.

3.

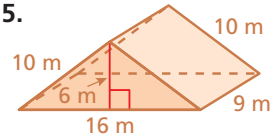


Find the surface area of the triangular prism.

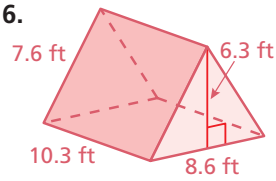
4.



5.



6.



8.2 Exercises

Check It Out
Help with Homework
BigIdeasMath.com

Vocabulary and Concept Check

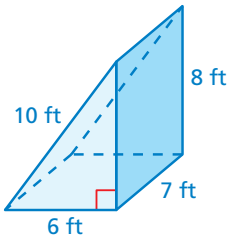
1. **VOCABULARY** Explain how to find the surface area of a prism.
2. **DIFFERENT WORDS, SAME QUESTION** Which is different? Find "both" answers.

What is the sum of the areas of the faces of the prism?

What is the area of the entire surface of the prism?

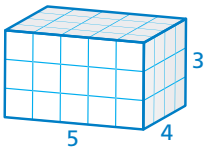
What is the area of the triangular faces of the prism?

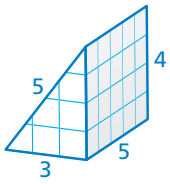
What is the surface area of the prism?

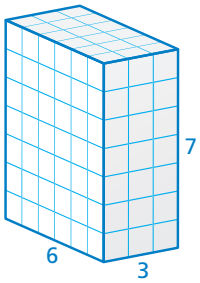


Practice and Problem Solving

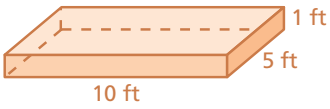
Draw a two-dimensional representation of the prism. Then find the area of the entire surface of the prism.

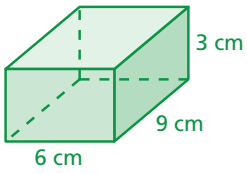
3. 

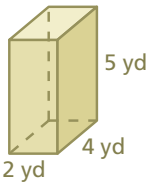
4. 

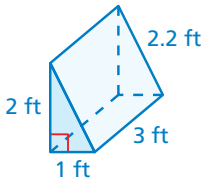
5. 

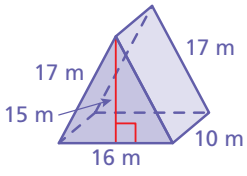
Find the surface area of the prism.

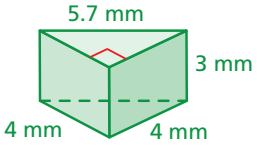
1 6. 

7. 

8. 

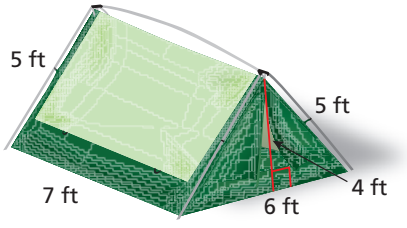
2 9. 

10. 

11. 

12. **GIFT BOX** A gift box in the shape of a rectangular prism measures 8 inches by 8 inches by 10 inches. What is the least amount of wrapping paper needed to wrap the gift box? Explain.

13. **TENT** What is the least amount of fabric needed to make the tent?



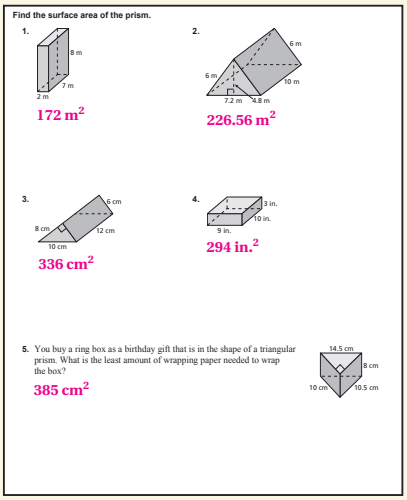
Assignment Guide and Homework Check

Level	Day 1 Activity Assignment	Day 2 Lesson Assignment	Homework Check
Basic	3–5, 18–21	1, 2, 7–15 odd	7, 11, 13, 15
Average	3–5, 18–21	1, 2, 6–16	7, 9, 12, 13 ,15
Advanced	3–5, 18–21	1, 2, 6–17	7, 9, 13, 15, 16

Common Errors

- **Exercises 3–11** Students may forget to count the surface area of the top and bottom faces. Remind them that they must count all of the faces, which includes the top and bottom as well as the sides.

8.2 Record and Practice Journal


Find the surface area of the prism.

1. 172 m^2

2. 226.56 m^2

3. 336 cm^2

4. 294 $in.^2$

5. You buy a ring box as a birthday gift that is in the shape of a triangular prism. What is the least amount of wrapping paper needed to wrap the box?
385 cm^2

Vocabulary and Concept Check

1. Find the sum of the areas of the faces.
2. What is the area of the triangular faces of the prism?; 48 ft^2; 216 ft^2

Practice and Problem Solving

3–5. See Additional Answers.

6. 130 ft^2

7. 198 cm^2

8. 76 yd^2

9. 17.6 ft^2

10. 740 m^2

11. 57.1 mm^2

12. 448 $in.^2$; The surface area of the box is 448 square inches, so that is the least amount of paper needed to cover the box.

13. 136 ft^2

Practice and Problem Solving

14. 83 ft^2

15. See *Taking Math Deeper*.

16. 2 qt

17. 364 ft^2

Fair Game Review

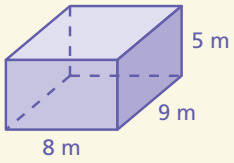
18. 48 m^2 **19.** 165 ft^2

20. 15 $in.^2$ **21.** C

Mini-Assessment

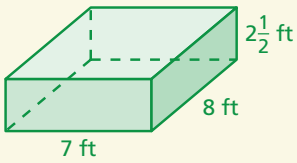
Find the surface area of the rectangular prism.

1.



314 m^2

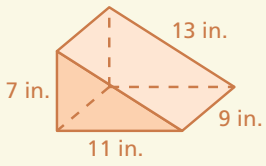
2.



187 ft^2

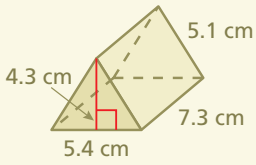
Find the surface area of the triangular prism.

3.



356 $in.^2$

4.



137.1 cm^2

Taking Math Deeper

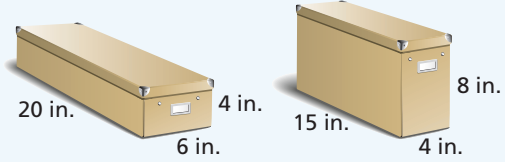
Exercise 15

This is a classic type of problem in manufacturing. For a given volume, what is the least amount of material I can use? The general answer is that the more cube-like, the more efficient the use of material. For instance, a cube-like tissue box is much more cost effective than a cereal box.

1 Help me see it.

Each storage box has a volume of 480 cubic inches. However, the shapes are quite different.

Box 1 Box 2



2 Find the surface area of each—in square feet.

Box 1

$2(20 \cdot 4) + 2(20 \cdot 6) + 2(4 \cdot 6) = 448\ in.^2 \approx 3.11\ ft^2$

Box 2

$2(15 \cdot 8) + 2(15 \cdot 4) + 2(8 \cdot 4) = 424\ in.^2 \approx 2.94\ ft^2$

Divide by 144 to get square feet.

3 Find the cost of each type and answer the question.

Box 1 Cost: $50(3.11\ ft^2)\left(1.25\ \frac{\$}{ft^2}\right) \approx \$194.38$

Box 2 Cost: $50(2.94\ ft^2)\left(1.25\ \frac{\$}{ft^2}\right) = \$183.75$

A company saves \$10.63 by using Box 2.

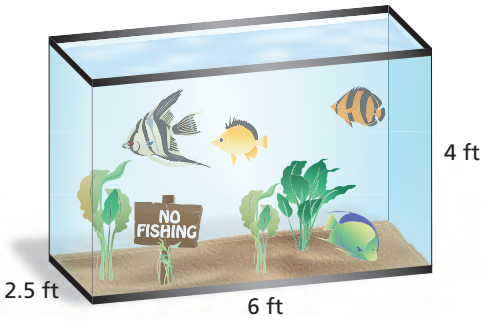
A more exact answer of \$10.42 can be found when the surface areas of the boxes are left in fraction form.

Project

Design a box that would have a volume of 480 cubic inches using the least possible amount of cardboard.

Reteaching and Enrichment Strategies

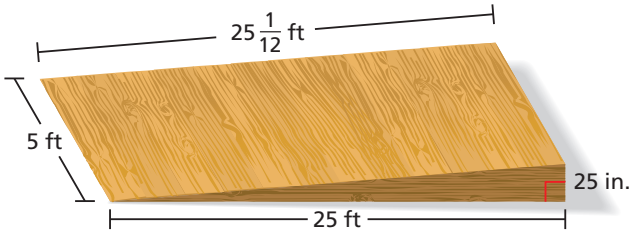
If students need help. . .	If students got it. . .
Resources by Chapter • Practice A and Practice B • Puzzle Time Record and Practice Journal Practice Differentiating the Lesson Lesson Tutorials Skills Review Handbook	Resources by Chapter • Enrichment and Extension • Technology Connection Start the next section



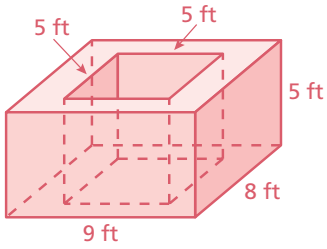
14. **AQUARIUM** A public library has an aquarium in the shape of a rectangular prism. The base is 6 feet by 2.5 feet. The height is 4 feet. How many square feet of glass were used to build the aquarium? (The top of the aquarium is open.)

15. **STORAGE BOX** The material used to make a storage box costs \$1.25 per square foot. The boxes have the same volume. How much does a company save by choosing to make 50 of Box 2 instead of 50 of Box 1?

	Length	Width	Height
Box 1	20 in.	6 in.	4 in.
Box 2	15 in.	4 in.	8 in.



16. **RAMP** A quart of stain covers 100 square feet. How many quarts should you buy to stain the wheelchair ramp? (Assume you do not have to stain the bottom of the ramp.)

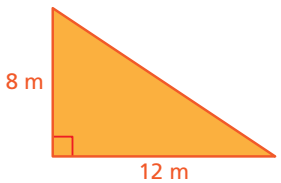


17. Critical Thinking A cube is removed from a rectangular prism. Find the surface area of the figure after removing the cube.

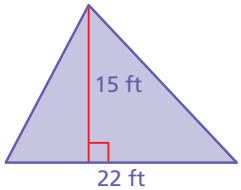
Fair Game Review What you learned in previous grades & lessons

Find the area of the triangle. *(Section 4.2)*

18.



19.



20.

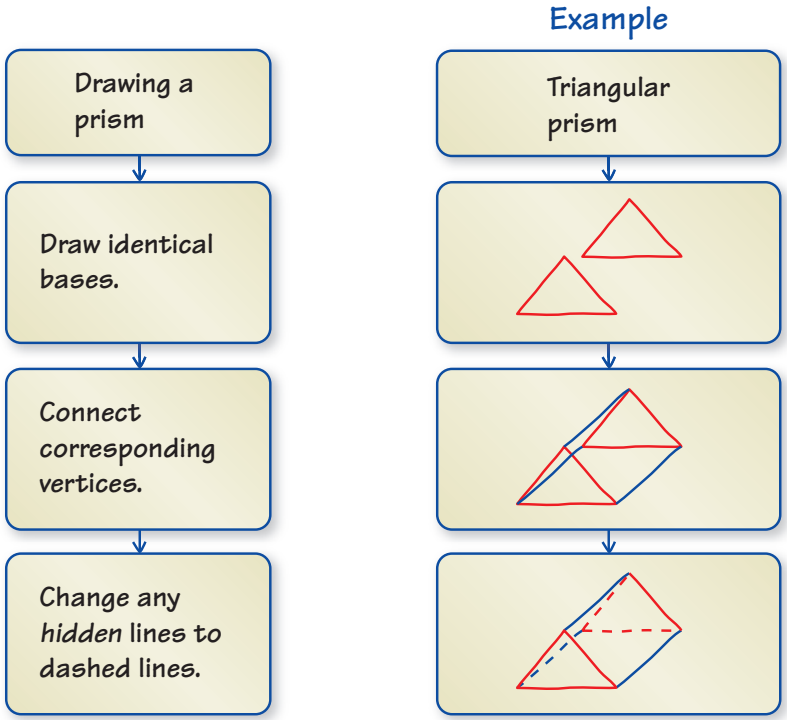
21. **MULTIPLE CHOICE** Which value is *not* a solution of the inequality $x - 4 \geq 2$? *(Section 7.5)*

(A) $x = 10$ (B) $x = 6$ (C) $x = 4$ (D) $x = 14$

8 Study Help

Check It Out
Graphic Organizer
BigIdeasMath.com

You can use a **process diagram** to show the steps involved in a procedure. Here is an example of a process diagram for drawing a prism.



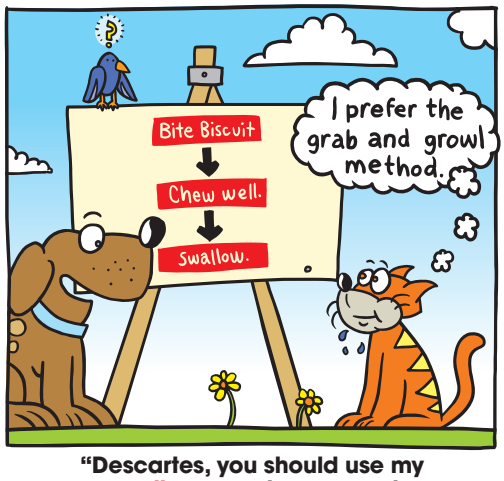
On Your Own

Make process diagrams with examples to help you study these topics.

1. drawing a pyramid
2. finding the surface area of a prism

After you complete this chapter, make process diagrams with examples for the following topics.

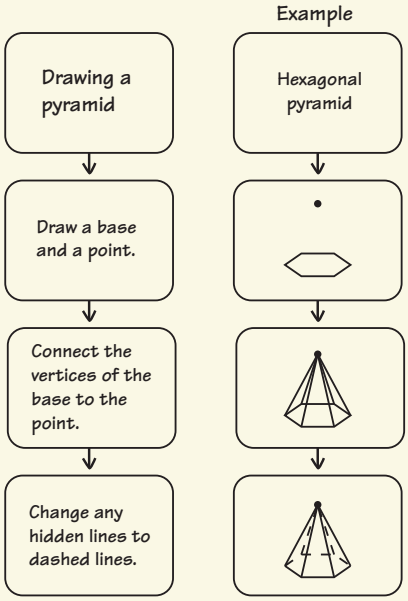
3. finding the surface area of a pyramid
4. finding the volume of a rectangular prism



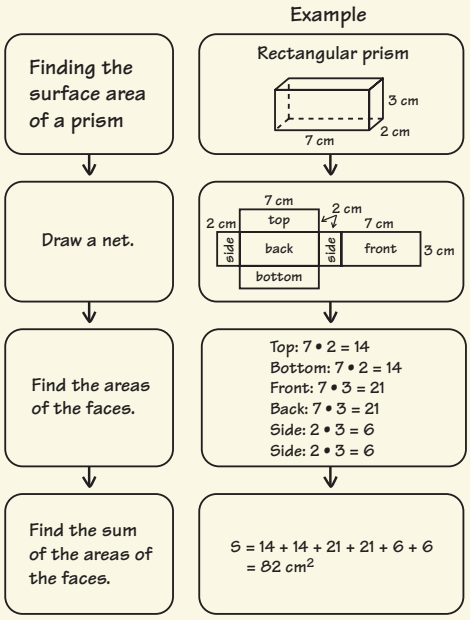
"Descartes, you should use my process diagram when you eat your treats."

Sample Answers

1.



2.



List of Organizers

Available at *BigIdeasMath.com*

Comparison Chart
Concept Circle
Definition (Idea) and Example Chart
Example and Non-Example Chart
Formula Triangle
Four Square
Information Frame
Information Wheel
Notetaking Organizer
Process Diagram
Summary Triangle
Word Magnet
Y Chart

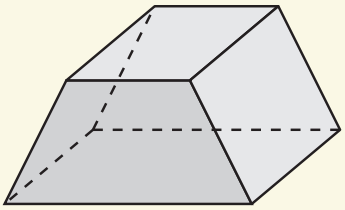
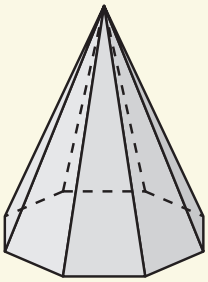
About this Organizer

A **Process Diagram** can be used to show the steps involved in a procedure. Process diagrams are particularly useful for illustrating procedures with two or more steps, and they can have one or more branches. As shown, students' process diagrams can have two parallel parts, in which the procedure is stepped out in one part and an example illustrating each step is shown in the other part. Or, the diagram can be made up of just one part, with example(s) included in the last "bubble" to illustrate the steps that precede it.

Technology for the Teacher

Editable Graphic Organizer

Answers

1. 6 faces, 12 edges, 8 vertices
2. 4 faces, 6 edges, 4 vertices
3. 
4. 
5. Front:  Side: 
   Top: 
6. Front:  Side: 
   Top: 
7. 132 cm^2
8. 52 $in.^2$
9. **a.** 384 $in.^2$
   b. 94 $in.^2$
10. 390 cm^2

Alternative Quiz Ideas

100% Quiz	**Math Log**
Error Notebook	Notebook Quiz
Group Quiz	Partner Quiz
Homework Quiz	Pass the Paper

Math Log

Ask students to keep a math log for the chapter. Have them include diagrams, definitions, and examples. Everything should be clearly labeled. It might be helpful if they put the information in a chart. Students can add to the log as new topics are introduced.

Reteaching and Enrichment Strategies

If students need help. . .	If students got it. . .
Resources by Chapter • Practice A and Practice B • Puzzle Time Lesson Tutorials *BigIdeasMath.com*	Resources by Chapter • Enrichment and Extension • Technology Connection Game Closet at *BigIdeasMath.com* Start the next section

Technology for the Teacher

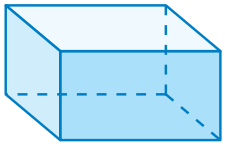
Online Assessment
Assessment Book
ExamView® Assessment Suite

8.1–8.2 Quiz

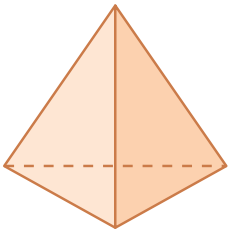
Check It Out
Progress Check
BigIdeasMath.com

Find the number of faces, edges, and vertices of the solid. *(Section 8.1)*

1.



2.



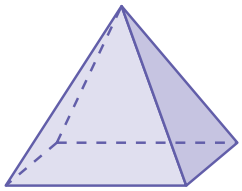
Draw the solid. *(Section 8.1)*

3. trapezoidal prism

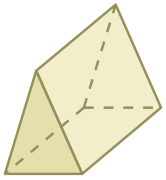
4. octagonal pyramid

Draw the front, side, and top views of the solid. *(Section 8.1)*

5.

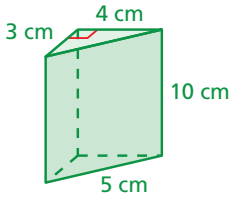


6.

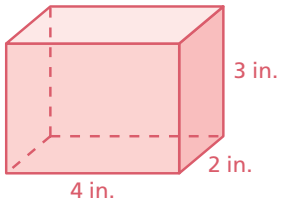


Find the surface area of the prism. *(Section 8.2)*

7.



8.



9. **CEREAL** A cereal box has the dimensions shown. *(Section 8.2)*

a. Find the surface area of the cereal box.

b. The manufacturer decides to decrease the size of the box by reducing each of the dimensions by 1 inch. Find the decrease in surface area.

10. **GIFT BOX** Find the surface area of the gift box. *(Section 8.2)*

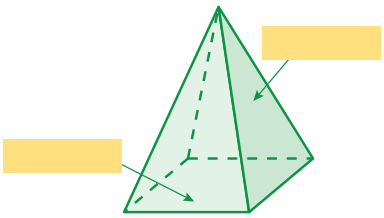
8.3 Surface Areas of Pyramids

Essential Question How can you use a net to find the surface area of a pyramid?

1 ACTIVITY: Identifying Pyramids

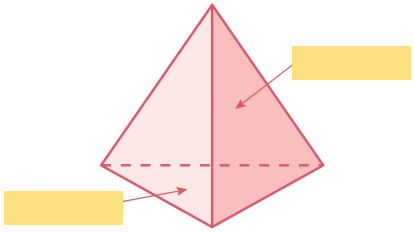
Work with a partner. Label one of the faces as a "base" and the other as a "lateral face." Use the shape of the base to identify the pyramid.

a.



_____ **Pyramid**

b.



_____ **Pyramid**

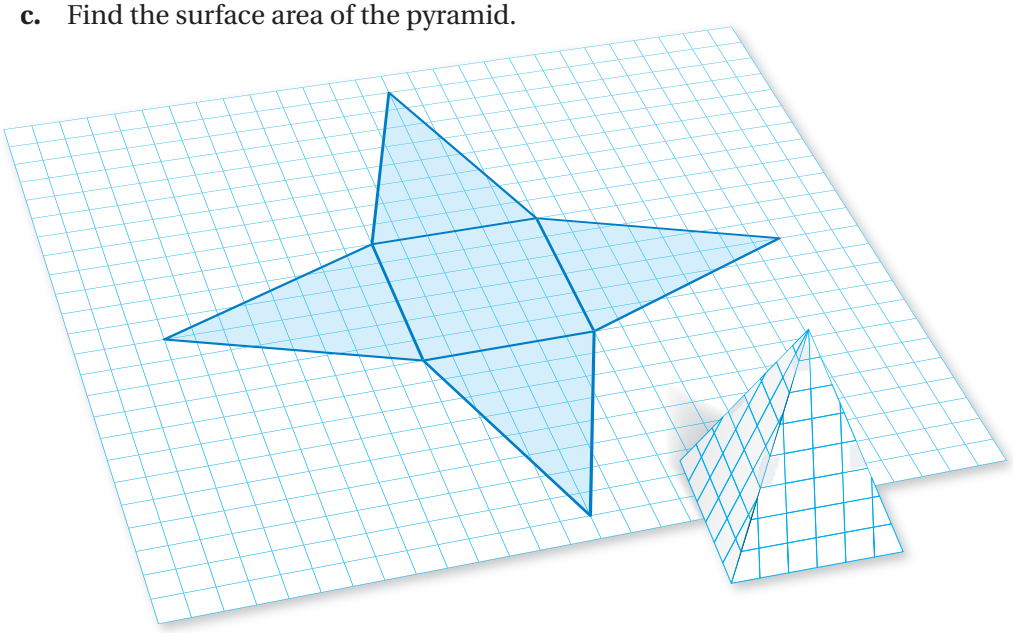
2 ACTIVITY: Using a Net

Work with a partner.

a. Copy the net shown below onto grid paper.

b. Cut out the net and fold it to form a pyramid. What type of rectangle is the base? Use this shape to name the pyramid.

c. Find the surface area of the pyramid.



Geometry

In this lesson, you will

- use nets to represent pyramids.
- find the surface area of pyramids.
- solve real-life problems.

Laurie's Notes

Introduction

Standards for Mathematical Practice

- **MP8 Look for and Express Regularity in Repeated Reasoning:** Students will be finding the surface areas of several pyramids. In doing so they may discover an efficient method. For instance, a pyramid with a regular base has congruent lateral faces. Finding the area of one lateral face and multiplying by the number of lateral faces is more efficient than doing multiple computations.

For Your Information

- The term *lateral face* is used in the activity. *Lateral surface area* is taught in Grade 7.
- To introduce surface area of pyramids, all pyramids in this section are right pyramids and have regular bases (squares and equilateral triangles).

Motivate

- Show a picture of the Louvre pyramid in Paris. It was designed by I.M. Pei. as the Louvre's main entrance, which is used to handle the enormous number of visitors on an everyday basis.
- I.M. Pei also designed the East Building of the National Gallery of Art in Washington, D.C., and the Rock and Roll Hall of Fame in Cleveland, Ohio.

Activity Notes

Activity 1

- Students should work with their partners to identify the base and lateral face of each pyramid.
- Like a prism, a pyramid is further identified by the type of base it has.
- Check to see that the pyramids are named correctly.

Activity 2

- **Teaching Tip:** To avoid having scraps of paper on the floor, recycle plastic bags and tape them to desks around the room. There should be a bag close enough to each group so that there is no excuse for leaving a mess.
- In order to correctly copy the figure, students will need to determine the base and height of each triangular face. In this activity, the base of the pyramid is a square meaning that all of the triangles are the same.
- **MP3 Construct Viable Arguments and Critique the Reasoning of Others:** If time permits, ask students questions about the pyramid they folded.

? "If you know the shape of the base, what do you know about the total number of faces?" total number of faces = number of sides of base + 1

? "If you know the shape of the base, what do you know about the total number of edges?" total number of edges = number of sides of base × 2

? "If you know the shape of the base, what do you know about the total number of vertices?" Total number of vertices = number of sides of base + 1

Common Core State Standards

6.G.4 Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.

Previous Learning

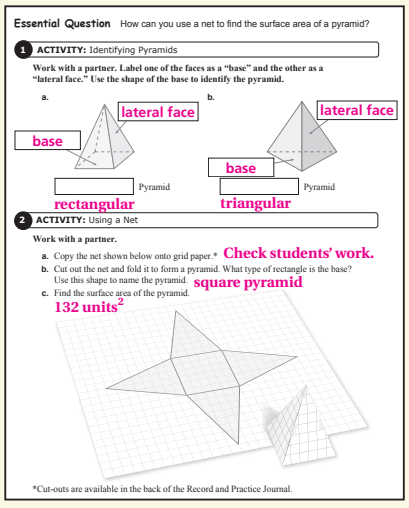
Students should know how to find the area of a triangle and should know the general properties of squares and isosceles triangles.

Technology for the Teacher

Dynamic Classroom

Lesson Plans
Complete Materials List

8.3 Record and Practice Journal



Essential Question How can you use a net to find the surface area of a pyramid?

1 ACTIVITY: Identifying Pyramids

Work with a partner. Label one of the faces as a "base" and the other as a "lateral face." Use the shape of the base to identify the pyramid.

a. lateral face, base, ____ Pyramid, rectangular

b. lateral face, base, ____ Pyramid, triangular

2 ACTIVITY: Using a Net

Work with a partner.

a. Copy the net shown below onto grid paper.* Check students' work.

b. Cut out the net and fold it to form a pyramid. What type of rectangle is the base? Use this shape to name the pyramid. square pyramid

c. Find the surface area of the pyramid. 132 units²

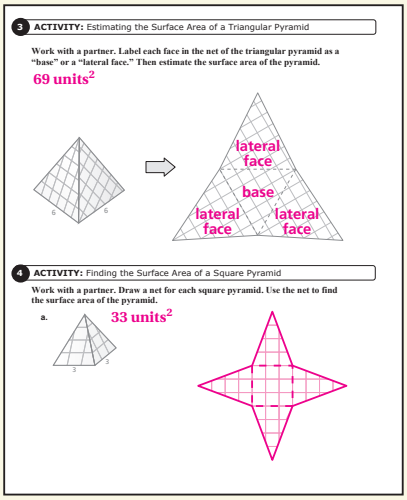
*Cut-outs are available in the back of the Record and Practice Journal.

English Language Learners

Vocabulary

Have students work in pairs, one English learner and one English speaker. Have each pair write a problem involving the surface area of a pyramid. On a separate piece of paper, students should solve their own problem. Then have students exchange their problem with another pair of students. Students solve the new problem. After solving the problems, the four students discuss the problems and solutions.

8.3 Record and Practice Journal



3 **ACTIVITY:** Estimating the Surface Area of a Triangular Pyramid

Work with a partner. Label each face in the net of the triangular pyramid as a "base" or a "lateral face." Then estimate the surface area of the pyramid.

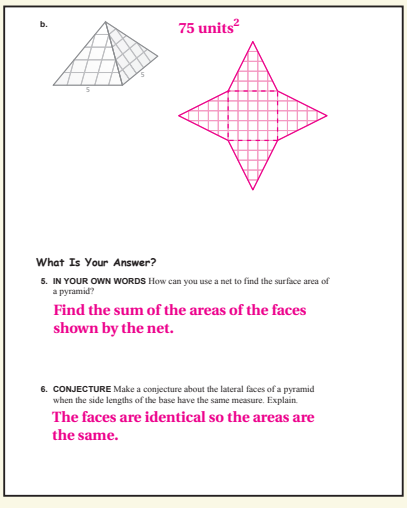
69 units^2

lateral face
base
lateral face
lateral face

4 **ACTIVITY:** Finding the Surface Area of a Square Pyramid

Work with a partner. Draw a net for each square pyramid. Use the net to find the surface area of the pyramid.

a. 33 units^2



b. 75 units^2

What Is Your Answer?

5. **IN YOUR OWN WORDS** How can you use a net to find the surface area of a pyramid?

Find the sum of the areas of the faces shown by the net.

6. **CONJECTURE** Make a conjecture about the lateral faces of a pyramid when the side lengths of the base have the same measure. Explain.

The faces are identical so the areas are the same.

Laurie's Notes

Activity 3

- Instead of cutting and folding up a prism as they did in Activity 2, this activity reverses that process. Students have to think about how the pyramid is unfolded to make the template shown.

? "How many faces does the pyramid have?" four "Are they all the same?" no "Describe the faces." There are 3 isosceles triangles and 1 equilateral triangle.

- The top isosceles triangle is positioned such that the height (6 units) and base (6 units) can be found easily. The side lengths of the equilateral triangle are 6 and the height is $\sqrt{27} \approx 5.2$. Because students are asked to estimate the surface area, it is okay to estimate the height as 5 units.
- **MP3** and **MP8:** When students have finished, ask volunteers to share how they found the surface area of the pyramid. There will be different strategies so expect all students to listen carefully to the process.

Activity 4

- **Scaffolding:** If time is a concern, have half of the class work on part (a) and the other half work on part (b).
- These drawings can be challenging for some students. Going from the solid to the two-dimensional representation is different than the reverse. If students are having trouble, suggest that they look back at Activity 2 for a hint as to how to sketch it.
- Although there are different two-dimensional representations (nets) that can be drawn for each pyramid, it is likely that students will draw a template similar to Activity 2. If time permits, investigate other nets. If you have snap together pieces, this is an easy way to investigate nets.

What Is Your Answer?

- Listen for a process that describes finding the sum of the areas of all of the lateral faces and the base.

Closure

- **Writing Prompt:** How is finding the surface area of a pyramid different from finding the surface area of a prism? To find the area of a pyramid you sum the area of the base and the triangular faces. To find the area of a prism you sum the area of the two bases and the rectangular lateral faces.

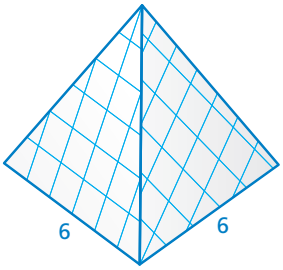
3 ACTIVITY: Estimating the Surface Area of a Triangular Pyramid

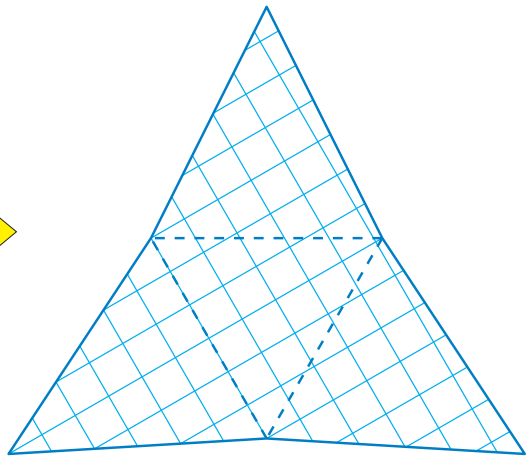
Work with a partner. Label each face in the net of the triangular pyramid as a "base" or a "lateral face." Then estimate the surface area of the pyramid.

Math Practice

Analyze Givens

What information is given in the diagram? How does this help you estimate the surface area of the pyramid?

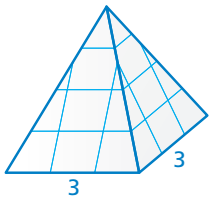




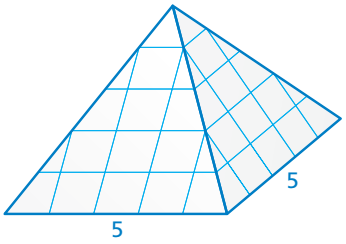
4 ACTIVITY: Finding the Surface Area of a Square Pyramid

Work with a partner. Draw a net for each square pyramid. Use the net to find the surface area of the pyramid.

a.



b.



What Is Your Answer?

5. **IN YOUR OWN WORDS** How can you use a net to find the surface area of a pyramid?

6. **CONJECTURE** Make a conjecture about the lateral faces of a pyramid when the side lengths of the base have the same measure. Explain.

Practice Use what you learned about the surface area of a pyramid to complete Exercises 3–5 on page 372.

8.3 Lesson

Check It Out
Lesson Tutorials
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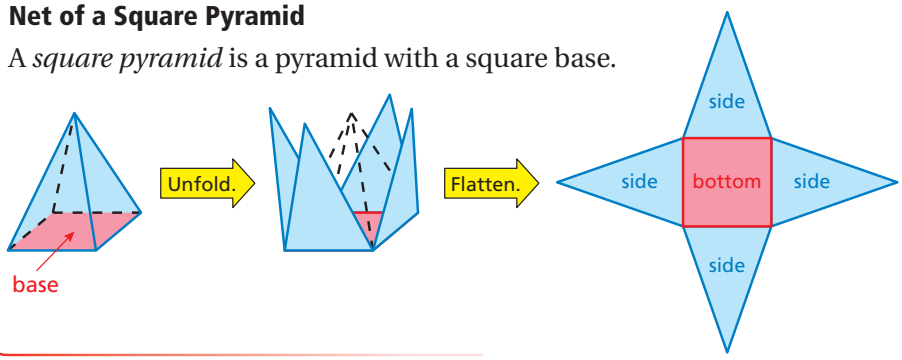
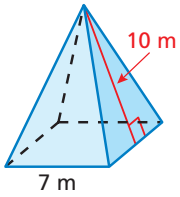
Key Idea

Net of a Square Pyramid

A *square pyramid* is a pyramid with a square base.



EXAMPLE 1 Finding the Surface Area of a Square Pyramid



Find the surface area of the square pyramid.

Use a net to find the area of each face.

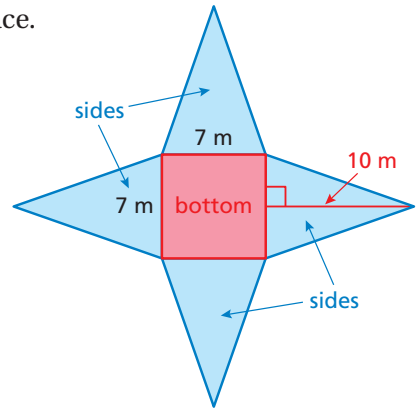
Bottom: $7 \cdot 7 = 49$

Side: $\frac{1}{2} \cdot 7 \cdot 10 = 35$

Side: $\frac{1}{2} \cdot 7 \cdot 10 = 35$

Side: $\frac{1}{2} \cdot 7 \cdot 10 = 35$

Side: $\frac{1}{2} \cdot 7 \cdot 10 = 35$



Find the sum of the areas of the faces.

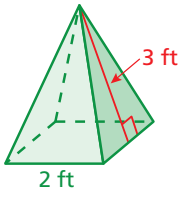
$$\begin{array}{rcccccccccc} \text{Surface Area} & = & \text{Area of bottom} & + & \text{Area of a side} & + & \text{Area of a side} & + & \text{Area of a side} & + & \text{Area of a side} \\ S & = & 49 & + & 35 & + & 35 & + & 35 & + & 35 = 189 \end{array}$$

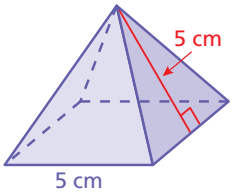
∴ So, the surface area is 189 square meters.

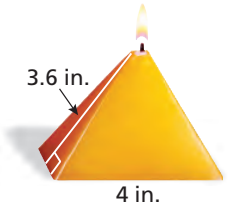
On Your Own

Now You're Ready
Exercises 6–8

Find the surface area of the square pyramid.

1. 

2. 

3. 

Laurie's Notes

Introduction

Connect

- **Yesterday:** Students worked with two-dimensional representations (nets) of pyramids and found the area of each face. (MP3, MP8)
- **Today:** Students will use a net to find the surface area of a pyramid.

Motivate

- Ask students where they have heard about pyramids or have seen them before. Give groups of students 3–4 minutes to brainstorm a list. They may mention the pyramid on the back of U.S. dollar bills, camping tents, roof designs, tetrahedral dice, and of course, Egyptian pyramids.

Lesson Notes

Key Idea

- Having a physical model of a square pyramid to refer to will be helpful. Use a paper model or commercially made model if you have one.
- Note that the base and lateral faces are labeled as *bottom* and *side* when the pyramid is unfolded as a net.

Example 1

- Draw the net and label the known information.

? "What do we need to do in order to find the surface area of this square pyramid?" Find the area of the base and each of the lateral faces.

- Write the *formula* for surface area in words as shown.

? "What is the area of the bottom (base)?" 49 square meters

? "What is the area of each side (lateral face)?" 35 square meters

? **Common Error:** In using the area formula for a triangle, the $\frac{1}{2}$ often produces a computation mistake. In this instance, students must multiply $\frac{1}{2} \times 7 \times 10$. Remind students that it's okay to change the order of the factors (Commutative Property). Rewriting the problem as $\frac{1}{2} \times 10 \times 7$ means that you can work with whole numbers: $\frac{1}{2} \times 10 \times 7 = 5 \times 7 = 35$.

- **MP8 Look for and Express Regularity in Repeated Reasoning:** Students may ask about the repeated steps of finding the area of each lateral face. Ask them to conjecture about an alternate way to find the surface area. Listen for (surface area) = (area of bottom) + 4 × (area of a side).

On Your Own

- Each of the problems is a square pyramid. Remind students to find the area of the square base, followed by the areas of the four triangles.
- Check to see that students label their answers the with correct units.

Goal Today's lesson is finding the surface areas of pyramids using nets.

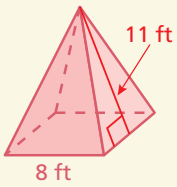
Technology for the Teacher

Dynamic Classroom

Lesson Tutorials
Lesson Plans
Answer Presentation Tool

Extra Example 1

Find the surface area of the square pyramid.



240 ft^2

On Your Own

1. 16 ft^2
2. 75 cm^2
3. 44.8 in.^{2}

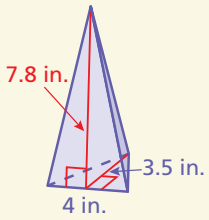
Differentiated Instruction

Kinesthetic

Photocopy nets of solids for students to cut out and assemble. Then have students draw their own nets to cut out and assemble.

Extra Example 2

Find the surface area of the triangular pyramid.



53.8 in.^{2}

On Your Own

4. 10.7 cm^2
5. 129.6 in.^{2}
6. 533 yd^2

Laurie's Notes

Key Ideas

- Write the Key Idea.
- Having a physical model of a triangular pyramid to refer to will be helpful. Use a paper model or commercially made model if you have one.
- As stated in the Study Tip, all of the triangular pyramids in this section will have an equilateral triangle for a base. The base and height of the triangular base and the lateral faces will be given.

Example 2

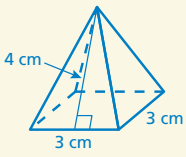
- Drawing the net is an important step. It allows the key dimensions to be labeled in a way that can be seen.
- Ask students to estimate the area of the base before computing. $\left(\frac{1}{2} \times 6 \times 5 = 15\right)$.
- **MP8:** Students may ask about the repeated steps of finding the area of each lateral face. Ask if their conjecture from Example 1 still holds. Listen for reasoning about the number of lateral faces being different so (surface area) = (area of bottom) + 3 × (area of a side).

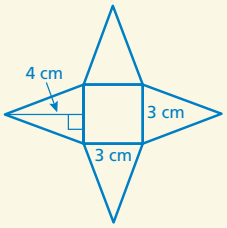
On Your Own

- Each of the problems is a triangular pyramid. Remind students to find the area of the triangular base, followed by the areas of the three side triangles.
- Ask volunteers to share their work at the board.
- **Common Error:** Working with decimals may cause errors. Encourage students to estimate their answer before multiplying.
- Check to see that students label their answers with correct units.

Closure

- **Exit Ticket:** Sketch a square pyramid with a slant height of 4 centimeters and a base side length of 3 centimeters. Sketch the net and find the surface area. 33 cm^2

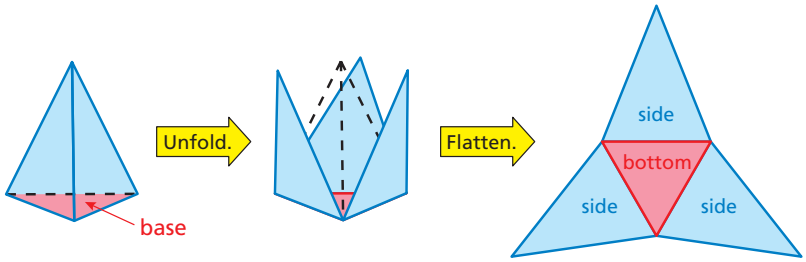




Key Idea

Net of a Triangular Pyramid

A *triangular pyramid* is a pyramid with a triangular base.

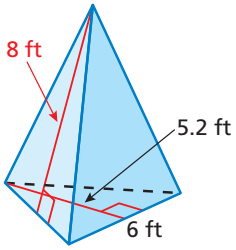


Study Tip

The base of each triangular pyramid in this section is an equilateral triangle.

EXAMPLE 2 Finding the Surface Area of a Triangular Pyramid

Find the surface area of the triangular pyramid.



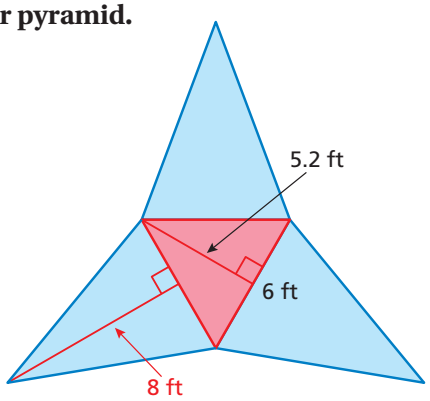
Use a net to find the area of each face.

Bottom: $\frac{1}{2} \cdot 6 \cdot 5.2 = 15.6$

Side: $\frac{1}{2} \cdot 6 \cdot 8 = 24$

Side: $\frac{1}{2} \cdot 6 \cdot 8 = 24$

Side: $\frac{1}{2} \cdot 6 \cdot 8 = 24$



Find the sum of the areas of the faces.

$$\begin{aligned} \text{Surface Area} &= \text{Area of bottom} + \text{Area of a side} + \text{Area of a side} + \text{Area of a side} \\ S &= 15.6 + 24 + 24 + 24 \\ &= 87.6 \end{aligned}$$

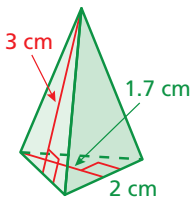
∴ So, the surface area is 87.6 square feet.

On Your Own

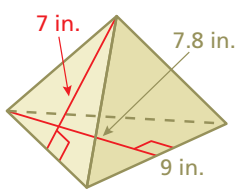
Now You're Ready
Exercises 9–11

Find the surface area of the triangular pyramid.

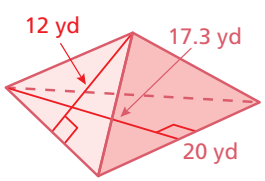
4.



5.



6.

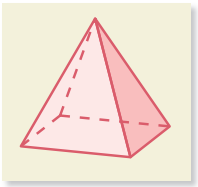
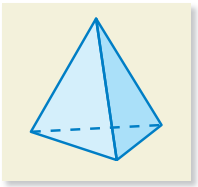
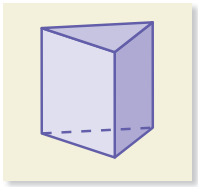
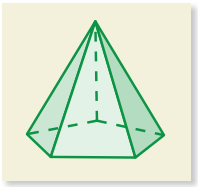


8.3 Exercises

Check It Out
Help with Homework
BigIdeasMath.com

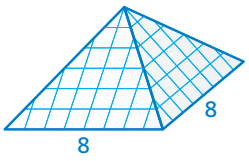
Vocabulary and Concept Check

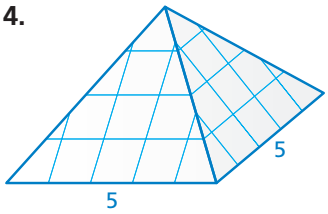
1. **PRECISION** Explain how to find the surface area of a pyramid.
2. **WHICH ONE DOESN'T BELONG?** Which figure does *not* belong with the other three? Explain your reasoning.

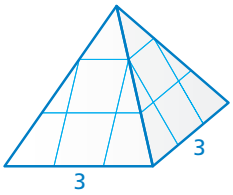





Practice and Problem Solving

Draw a net of the square pyramid. Then find the surface area of the pyramid.

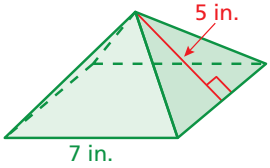
3. 

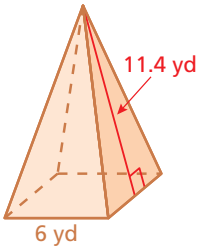
4. 

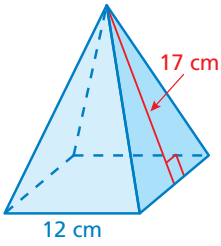
5. 

Find the surface area of the pyramid. The side lengths of the base are equal.

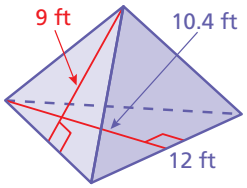
1

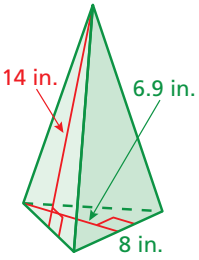
6. 

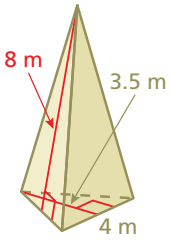
7. 

8. 

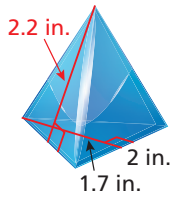
2

9. 

10. 

11. 

12. **PAPERWEIGHT** A paperweight is shaped like a triangular pyramid. The base is an equilateral triangle. Find the surface area of the paperweight.



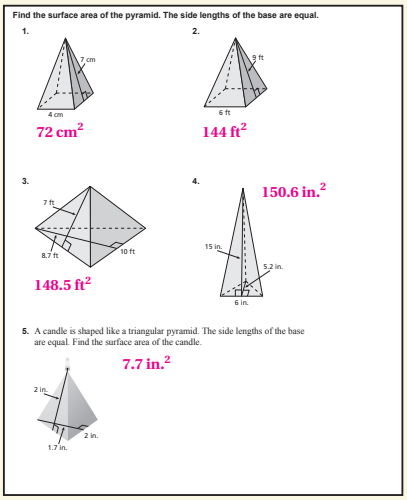
Assignment Guide and Homework Check

Level	Day 1 Activity Assignment	Day 2 Lesson Assignment	Homework Check
Basic	3–5, 18–20	1, 2, 7–15 odd	7, 11, 13, 15
Average	3–5, 18–20	1, 2, 6–12 even, 13–16	8, 10, 12, 14
Advanced	3–5, 18–20	1, 2, 6–17	8, 10, 12, 15, 16

Common Errors

- **Exercises 6–11** Students may forget to add on the area of the base when finding the surface area. Remind them that when asked to find the surface area, the base is included.
- **Exercises 6–11** Students may add the wrong number of lateral face areas to the area of the base. Examine several different pyramids with different bases and ask if they can find a relationship between the number of sides of the base and the number of lateral faces. (They are the same.) Remind students that the number of sides on the base determines how many triangles make up the lateral surface area.
- **Exercises 9–11** Students may forget to multiply by $\frac{1}{2}$ when finding the area of the base triangle. Remind them that the formula for the area of a triangle is $\frac{1}{2}bh$.

8.3 Record and Practice Journal


Find the surface area of the pyramid. The side lengths of the base are equal.

1. 7 cm, 4 cm — 72 cm²

2. 9 ft, 6 ft — 144 ft²

3. 7 ft, 8.7 ft, 10 ft — 148.5 ft²

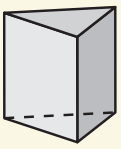
4. 15 in., 5.2 in., 6 in. — 150.6 in.²

5. A candle is shaped like a triangular pyramid. The side lengths of the base are equal. Find the surface area of the candle.

2 in., 2 in., 1.7 in. — 7.7 in.²

Vocabulary and Concept Check

1. Find the sum of the areas of the faces.

2. 

This figure is a prism and the other three figures are pyramids.

Practice and Problem Solving

3–5. See Additional Answers.

6. 119 in.^{2}

7. 172.8 yd^2

8. 552 cm^2

9. 224.4 ft^2

10. 195.6 in.^{2}

11. 55 m^2

12. 8.3 in.^{2}

13. 21,274.4 ft^2

14. yes; The weight of the glass is 19.6 pounds, which is less than the limit of 35 pounds for the chain.

15. 4

16. See *Taking Math Deeper*.

17. no; You can place the four triangles on top of the square and it covers the entire square. But when you lift up the triangles, they do not touch. So, they do not form a pyramid.

Fair Game Review

18.

Frogs	7	14	28
Turtles	3	6	12

7 : 3, 14 : 6, 28 : 12

19.

Apples	10	5	30
Oranges	4	2	12

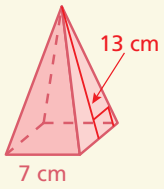
10 : 4, 5 : 2, 30 : 12

20. B

Mini-Assessment

Find the surface area of the square pyramid.

1.



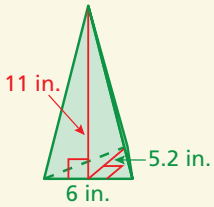
231 cm^2

2.

114.24 m^2

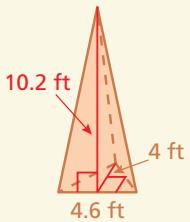
Find the surface area of the triangular pyramid.

3.



114.6 $in.^2$

4.



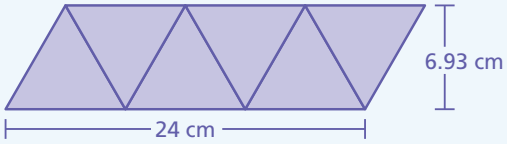
79.58 ft^2

Taking Math Deeper

Exercise 16

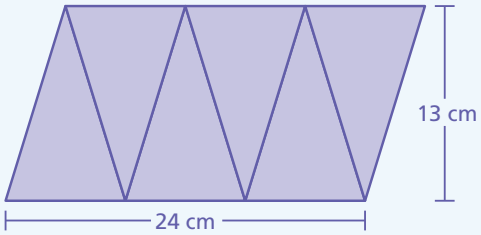
One way to solve this problem is to rearrange the base and the lateral faces into different shapes.

1 Find the area of the base by rearranging the triangles to form a parallelogram.



$A = bh = 24(6.93) = 166.32$ cm^2

2 Find the area of the lateral faces by rearranging them to form a parallelogram.



$A = bh = 24(13) = 312$ cm^2

3 So, the surface area of the hexagonal pyramid is 166.32 + 312 = 478.32 square centimeters.

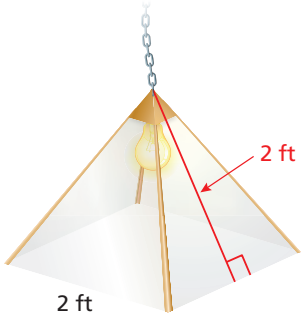
Project

Use grid paper to draw a net of the pyramid in Exercise 16. Cut out the net and fold it to form the pyramid.

Reteaching and Enrichment Strategies

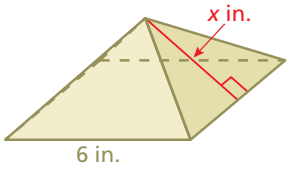
If students need help. . .	If students got it. . .
Resources by Chapter • Practice A and Practice B • Puzzle Time Record and Practice Journal Practice Differentiating the Lesson Lesson Tutorials Skills Review Handbook	Resources by Chapter • Enrichment and Extension • Technology Connection Start the next section

13. LOUVRE The entrance to the Louvre Museum in Paris, France, is a square pyramid. The side length of the base is 116 feet, and the height of one of the triangular faces is 91.7 feet. Find the surface area of the four triangular faces of the entrance to the Louvre Museum.

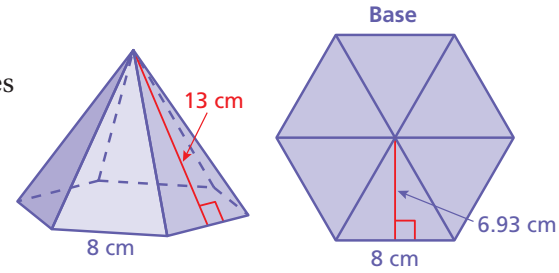


14. LIGHT COVER A hanging light cover made of glass is shaped like a square pyramid. The cover does not have a bottom. One square foot of the glass weighs 2.45 pounds. The chain can support 35 pounds. Will the chain support the light cover? Explain.

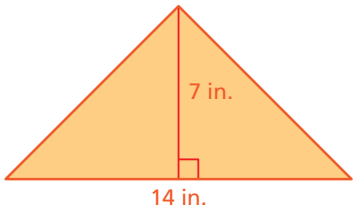
15. GEOMETRY The surface area of a square pyramid is 84 square inches. The side length of the base is 6 inches. What is the value of x?



16. STRUCTURE In the diagram of the base of the hexagonal pyramid, all the triangles are the same. Find the surface area of the hexagonal pyramid.



17. Critical Thinking Can you form a square pyramid using four of the triangles shown? Explain your reasoning.



Fair Game Review What you learned in previous grades & lessons

Find the missing values in the ratio table. Then write the equivalent ratios. *(Section 5.2)*

18.

Frogs	7		28
Turtles	3	6	

19.

Apples	10	5	
Oranges	4		12

20. MULTIPLE CHOICE Which ordered pair is in Quadrant III? *(Section 6.5)*

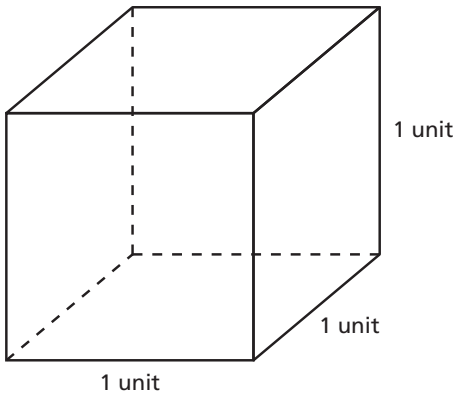
Ⓐ $(5, -1)$ Ⓑ $(-2, -3)$ Ⓒ $(2, 4)$ Ⓓ $(-7, 1)$

8.4 Volumes of Rectangular Prisms

Essential Question How can you find the volume of a rectangular prism with fractional edge lengths?

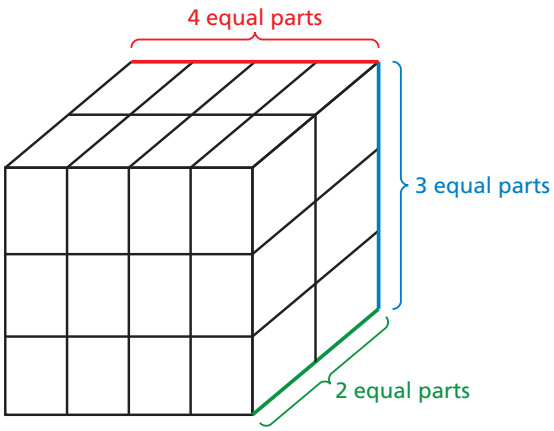
Recall that the **volume** of a three-dimensional figure is a measure of the amount of space that it occupies. Volume is measured in *cubic units*.

A *unit cube* is a cube with an edge length of 1 unit.



1 ACTIVITY: Using a Unit Cube

Work with a partner. The parallel edges of the unit cube have been divided into 2, 3, and 4 equal parts to create smaller rectangular prisms that are identical.



a. Draw one of these identical prisms and label its dimensions.

b. What fraction of the volume of the unit cube does one of these identical prisms represent? Use this value to find the volume of one of the identical prisms. Explain your reasoning.

Geometry

In this lesson, you will

- find the volume of prisms with fractional edge lengths by using models.
- find the volume of prisms by using formulas.

Laurie's Notes

Introduction

Standards for Mathematical Practice

- **MP3 Construct Viable Arguments and Critique the Reasoning of Others:** The essential question for this lesson is how to find the volume of a rectangular prism with fractional dimensions. Students will work through activities that will help them to make a connection to the volume formula they studied in Grade 5. As they make conjectures, students should be expected to listen carefully and critique the reasoning of their classmates.

Motivate

- Hold up a variety of common containers and ask what is commonly found inside. Examples: egg carton (12 eggs); playing cards box (52 cards); crayon box (8 crayons)
- Discuss with students these examples of volume. Each container is filled with objects of the same size. How many eggs fit in the egg carton, or how many crayons fit in the crayon box? Because the units are different (eggs, cards, crayons), you can't compare the volumes.

Activity Notes

Activity 1

- **FYI:** In Grade 5, students developed the volume formula $V = \ell wh$ for rectangular prisms with whole number dimensions. This activity focuses on finding the volume of a rectangular prism with fractional edge lengths.
- **Teaching Tip:** Make a unit cube out of poster board or construction paper. It's important that it not look like a cubic foot or cubic inch so that students are simply thinking of a unit cube as having all edges equal in length.

? Hold the unit cube and ask, "What name would you give this solid?" expect answers such as prism, cube, box

? "What is special about this prism?" All faces are the same size and shape. All edges have the same length.

- Say, "This is a unit cube. It is a prism with six square faces. In this first activity, you are going to divide up this cube. If helpful, think of it as a large chunk of cheese, and you're able to slice down through it!"
- When students have a sketch of part (a), ask a volunteer to share it with the class. You want to be sure that all students have the dimensions labeled correctly. In completing part (b), students will need to know how many identical prisms there are. You might suggest that they think about the layers, and how many prisms are in each layer.
- **MP3:** Ask volunteers to share their reasoning in part (b). Most students will think about the 24 identical prisms, so each must have a volume of $\frac{1}{24}$ cubic unit. Some students may think about the dimensions and use the formula they developed in Grade 5. They will also have a volume of $\frac{1}{24}$ cubic unit.
- Discuss the meaning of cubic units with students.

Common Core State Standards

6.G.2 Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas $V = \ell wh$ and $V = bh$ to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.

Previous Learning

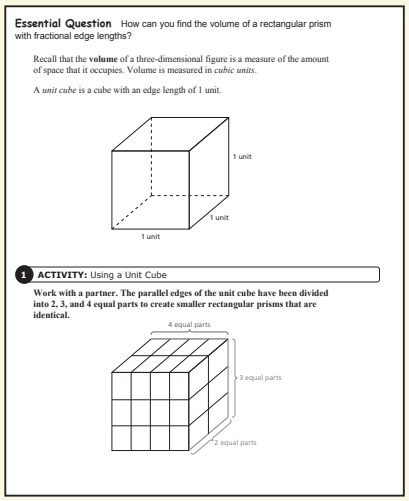
Students should know how to distinguish between perimeter, area, and volume, and how to determine the volume of a rectangular solid using cubes or pictorial representations.

Technology for the Teacher

Dynamic Classroom

Lesson Plans
Complete Materials List

8.4 Record and Practice Journal



Essential Question How can you find the volume of a rectangular prism with fractional edge lengths?

Recall that the **volume** of a three-dimensional figure is a measure of the amount of space that it occupies. Volume is measured in *cubic units*.

A *unit cube* is a cube with an edge length of 1 unit.

1 unit, 1 unit, 1 unit

1 ACTIVITY: Using a Unit Cube

Work with a partner. The parallel edges of the unit cube have been divided into 2, 3, and 4 equal parts to create smaller rectangular prisms that are identical.

4 equal parts, 3 equal parts, 2 equal parts

English Language Learners

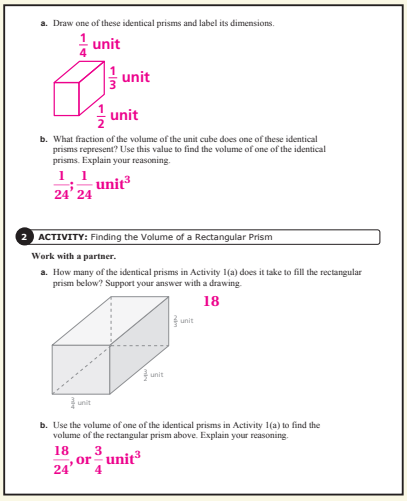
Forming Answers

Encourage English learners to form complete sentences in their responses. Students can use the question to help them form the answer.

Question: If you know the height and the width of a prism, what else do you need to know to find the volume?

Response: If you know the height and width of a prism, you need to know the length of the prism to find the volume.

8.4 Record and Practice Journal



a. Draw one of these identical prisms and label its dimensions.

$\frac{1}{4}$ unit, $\frac{1}{3}$ unit, $\frac{1}{2}$ unit

b. What fraction of the volume of the unit cube does one of these identical prisms represent? Use this value to find the volume of one of the identical prisms. Explain your reasoning.

$\frac{1}{24}$; $\frac{1}{24}$ unit^3

2 ACTIVITY: Finding the Volume of a Rectangular Prism

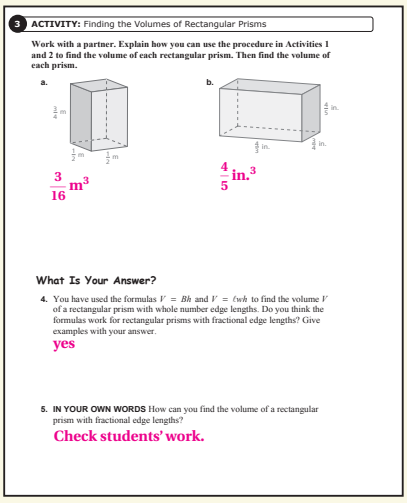
Work with a partner.

a. How many of the identical prisms in Activity 1(a) does it take to fill the rectangular prism below? Support your answer with a drawing.

18

b. Use the volume of one of the identical prisms in Activity 1(a) to find the volume of the rectangular prism above. Explain your reasoning.

$\frac{18}{24}$, or $\frac{3}{4}$ unit^3



3 ACTIVITY: Finding the Volumes of Rectangular Prisms

Work with a partner. Explain how you can use the procedure in Activities 1 and 2 to find the volume of each rectangular prism. Then find the volume of each prism.

a. $\frac{3}{16}$ m^3

b. $\frac{4}{5}$ in.^{3}

What Is Your Answer?

4. You have used the formulas $V = Bh$ and $V = \ell wh$ to find the volume V of a rectangular prism with whole number edge lengths. Do you think the formulas work for rectangular prisms with fractional edge lengths? Give examples with your answer.

yes

5. **IN YOUR OWN WORDS** How can you find the volume of a rectangular prism with fractional edge lengths?

Check students' work.

Laurie's Notes

Activity 2

- Help students see the connection between the denominators of the dimensions of the prism in Activity 2 (which are 2, 3, and 4) and the number of equal parts the unit cube was divided up into in Activity 1 (2, 3, and 4).
- Say, "If the width of the prism is $\frac{3}{4}$ you can think of it as three of four equal parts. Each part would be $\frac{1}{4}$-unit long." Use the same strategy for the thirds and halves.
- Students can sketch lines parallel to the edges to reveal the smaller prisms, all of which will have the same dimensions as Activity 1: $\frac{1}{2}$ by $\frac{1}{4}$ by $\frac{1}{3}$. From Activity 1 they know the volume of the small identical prisms is $\frac{1}{24}$ cubic unit. There are 18 of these prisms, therefore the volume of the prism is $\frac{18}{24}$ cubic units.
- **MP3:** Ask volunteers to share their reasoning in part (b). Again, students may recognize that an alternate way to find the volume is to multiply the dimensions of the original prism: Volume $= \frac{3}{4} \times \frac{3}{2} \times \frac{2}{3} = \frac{18}{24}$ cubic units.

Activity 3

- In this activity, students must think about how to divide up the prism.
- **MP1 Make Sense of Problems and Persevere in Solving Them:** Do not jump in too quickly to rescue students. Tell them that these two problems are similar to Activities 1 and 2. They need to think through what information is given and how the first two activities can help them.
- **MP3:** When students have finished, ask volunteers to share how they found the volume of each prism. There may be different strategies so expect all students to listen carefully to the process.

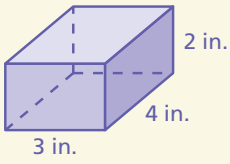
What Is Your Answer?

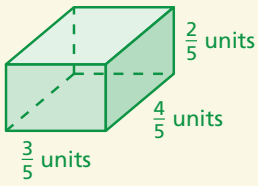
- In Question 4, the volume formula may have already come up during the activities. If not, students should now be able to make the connection by looking back at their results in each activity.

Closure

- Find the volume of each prism. How are the results the same?

  24 cubic inches; $\frac{24}{125}$ cubic units; The volume of each prism is 24 of its cubic units of measurement, 1 cubic inch and $\frac{1}{125}$ cubic unit.

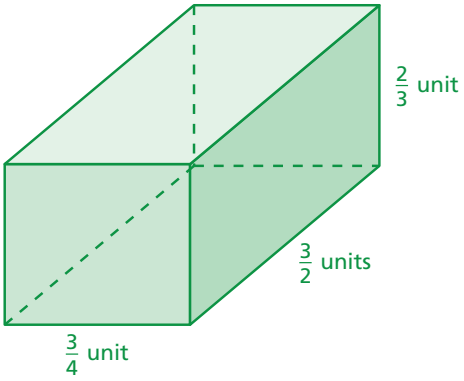




2 ACTIVITY: Finding the Volume of a Rectangular Prism

Work with a partner.

a. How many of the identical prisms in Activity 1(a) does it take to fill the rectangular prism below? Support your answer with a drawing.



b. Use the volume of one of the identical prisms in Activity 1(a) to find the volume of the rectangular prism above. Explain your reasoning.

Math Practice

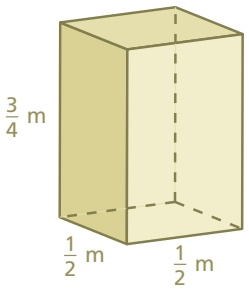
Analyze Relationships

What is the relationship between the solid shown here and the solid in the previous activity?

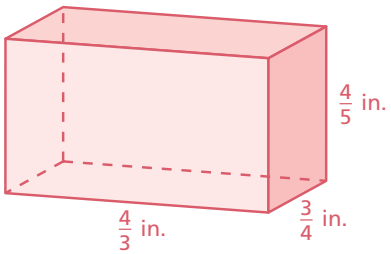
3 ACTIVITY: Finding the Volumes of Rectangular Prisms

Work with a partner. Explain how you can use the procedure in Activities 1 and 2 to find the volume of each rectangular prism. Then find the volume of each prism.

a.



b.



What Is Your Answer?

4. You have used the formulas $V = Bh$ and $V = \ell wh$ to find the volume V of a rectangular prism with whole number edge lengths. Do you think the formulas work for rectangular prisms with fractional edge lengths? Give examples with your answer.

5. **IN YOUR OWN WORDS** How can you find the volume of a rectangular prism with fractional edge lengths?

Practice Use what you learned about the volume of a rectangular prism to complete Exercises 4–6 on page 378.

8.4 Lesson

Check It Out
Lesson Tutorials
BigIdeasMath.com

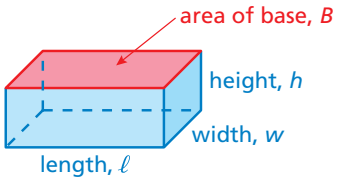
Key Vocabulary
volume, *p. 374*

Key Idea

Volume of a Rectangular Prism

Words The volume V of a rectangular prism is the product of the area of the base and the height of the prism.

Algebra $V = Bh$ or $V = \ell wh$



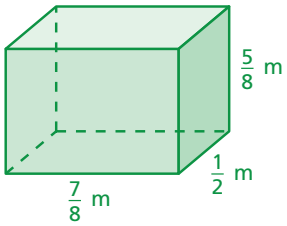
EXAMPLE 1 Finding Volumes of Rectangular Prisms

Find the volume of each prism.

Study Tip

In Example 1(b), the rectangular prism is a cube. You can use the formula $V = s^3$ to find the volume V of a cube with an edge length of s.

a.



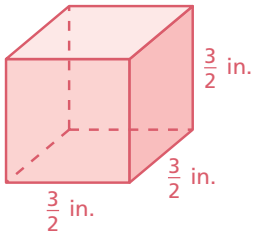
$V = \ell wh$ Write formula.

$= \frac{7}{8}\left(\frac{1}{2}\right)\left(\frac{5}{8}\right)$ Substitute values.

$= \frac{35}{128}$ Multiply.

∴ So, the volume is $\frac{35}{128}$ cubic meter.

b.



$V = \ell wh$

$= \frac{3}{2}\left(\frac{3}{2}\right)\left(\frac{3}{2}\right)$

$= \frac{27}{8}$

$= 3\frac{3}{8}$

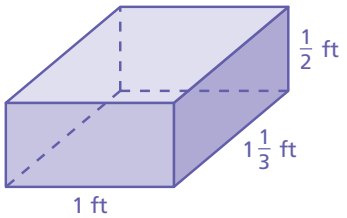
∴ So, the volume is $3\frac{3}{8}$ cubic inches.

On Your Own

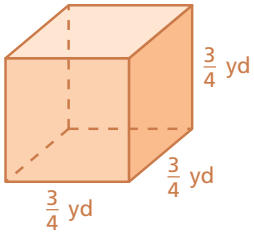
Now You're Ready
Exercises 4–9

Find the volume of the prism.

1.



2.



Multi-Language Glossary at BigIdeasMath.com

Laurie's Notes

Introduction

Connect

- **Yesterday:** Students explored how to find the volume of a rectangular prism with fractional dimensions. (MP1, MP3)
- **Today:** Students will use the formula for the volume of a rectangular prism to solve problems.

Motivate

- Hold up a tissue box and ask, "What does this prism hold?" tissues "How many?" Answers will vary.
- Hold up a ream of paper and ask, "What does this prism hold?" paper "How many sheets?" likely 500
- Ask students to think of other rectangular prisms whose volume is referred to by the contents, like the tissue box and ream of paper.
- Have students generate a list with their partners and then share.
- **Connection:** Similar to yesterday's Motivate, the layers help us to think about how to measure the space inside the prism.

Lesson Notes

Key Idea

- "What is a prism?" three-dimensional solid with two identical, parallel bases
- Point out to students that the dashed lines in the figure represent edges that cannot be seen from the perspective given.
- "Why is it called a *rectangular* prism?" The bases are rectangles.
- Write the formula for the volume of a rectangular prism in words and in symbols.
- **Review Vocabulary:** *Product* is the answer to a multiplication problem.

Example 1

- Write the formula for volume and substitute the value of each dimension.
- Note that parentheses are used to denote multiplication.
- After students have worked through each problem, ask them to use their hands to demonstrate the size of a cubic meter and a cubic inch.
- "How different are the two units?" open-ended

On Your Own

- "In Question 1, can the 1 ft and $\frac{1}{2}$ ft dimensions be the length and width, and the $1\frac{1}{3}$ ft dimension be the height? Explain." Yes, the bases of the prism would be the 1 ft by $\frac{1}{2}$ ft faces.
- **Extension:** Point out to students that in Question 2, all of the dimensions are in yards. "What would the dimensions be if they were labeled in feet?" $\frac{9}{4}$ feet "How would you find the volume?" $\left(\frac{9}{4}\right)^3$ "What units would be used in the answer?" cubic feet

Goal Today's lesson is finding the **volume** of a prism using a formula.

Technology for the Teacher

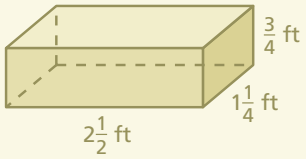
Dynamic Classroom

Lesson Tutorials
Lesson Plans
Answer Presentation Tool

Extra Example 1

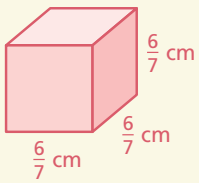
Find the volume of each prism.

a.



$2\frac{11}{32}$ ft^3

b.



$\frac{216}{343}$ cm^3

On Your Own

1. $\frac{2}{3}$ ft^3
2. $\frac{27}{64}$ yd^3

Extra Example 2

In Example 2, the length of the dump truck is 22 feet. How many pounds of dirt can the dump truck haul when it is full?
58,520 lb

Extra Example 3

An MP3 player has a depth (length) of 0.6 centimeter, a width of 4 centimeters, and a volume of 21.6 cubic centimeters. Write and solve an equation to find the height of the MP3 player.
$21.6 = 0.6(4)h$, 9 cm

On Your Own

3. 53,200 lb

4. $72 = \ell(6)(2)$; 6 in.

5. $1375 = 20(w)\left(5\frac{1}{2}\right)$; $12\frac{1}{2}$ cm

Differentiated Instruction

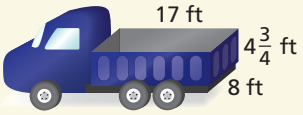
Kinesthetic

Divide the class into two groups. Give each group a piece of yarn or string 36 inches long. Have the first group use all of the yarn to form a rectangle with the largest possible area. Have the second group use all of the yarn to form a rectangle with the smallest possible area, with one side at least 1 inch long.
Ask students:
What are the dimensions of your rectangle? 9 in. by 9 in.; 1 in. by 17 in.
If the rectangle was the base of a prism having a height of 5 inches, what would the volume of the prism be? 405 in.^{3}; 85 in.^{3}
What is the difference between the two volumes? 320 in.^{3}

Laurie's Notes

Example 2

- It may be helpful to sketch and label the dump truck in the horizontal position.



- "Would a cubic foot of dirt fit in the wastebasket?" Answers will vary depending upon size of the wastebasket in the classroom.
- If the wastebasket is close to a cubic foot, relate this to the statement that a cubic foot of dirt weighs about 70 pounds.
- **MP6 Attend to Precision:** Note the use of dimensional analysis to show that the answer has units of pounds.
- **Extension:** "A ton is 2000 pounds. How many tons of dirt can the dump truck haul when it is full?" 22.61 tons

Example 3

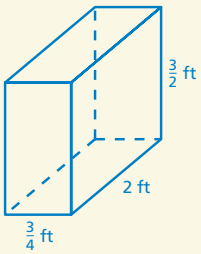
- Students worked with equation solving in the last chapter, so they should have little trouble with this problem.
- "What is known in this problem?" volume, length, and width "What are you trying to find out?" height
- "Is the answer reasonable? Explain." yes; Answers will vary.

On Your Own

- **Neighbor Check:** Have students work independently and then have their neighbors check their work. Have students discuss any discrepancies.

Closure

- **Exit Ticket:** Sketch a rectangular prism. Label the dimensions $\frac{3}{4}$ foot, 2 feet, and $\frac{3}{2}$ feet. Find the volume of the prism.



$V = \frac{3}{4} \cdot 2 \cdot \frac{3}{2} = 2\frac{1}{4}\text{ ft}^3$

EXAMPLE 2 Using the Volume of a Rectangular Prism

One cubic foot of dirt weighs about 70 pounds. How many pounds of dirt can the dump truck haul when it is full?

Find the volume of dirt that the dump truck can haul when it is full.

$V = \ell wh$ Write formula for volume.

$= 17(8)\left(4\frac{3}{4}\right)$ Substitute values.

$= 646$ Multiply.

So, the dump truck can haul 646 cubic feet of dirt when it is full. To find the weight of the dirt, multiply by $\frac{70 \text{ lb}}{1 \text{ ft}^3}$.

$$646 \text{ ft}^3 \times \frac{70 \text{ lb}}{1 \text{ ft}^3} = 45{,}220 \text{ lb}$$

∴ The dump truck can haul about 45,220 pounds of dirt when it is full.

EXAMPLE 3 Finding a Missing Dimension of a Rectangular Prism

Write and solve an equation to find the height of the computer tower.

Volume = 1792 in.^{3}

$V = \ell wh$ Write formula for volume.

$1792 = 16(7)h$ Substitute values.

$1792 = 112h$ Simplify.

$\frac{1792}{112} = \frac{112h}{112}$ Division Property of Equality

$16 = h$ Simplify.

∴ So, the height of the computer tower is 16 inches.

On Your Own

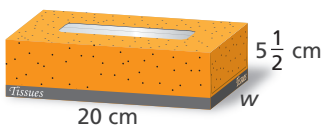
3. **WHAT IF?** In Example 2, the length of the dump truck is 20 feet. How many pounds of dirt can the dump truck haul when it is full?

Now You're Ready
Exercises 10–12

Write and solve an equation to find the missing dimension of the prism.

4. Volume = 72 in.^{3}

5. Volume = 1375 cm^3



8.4 Exercises

Check It Out
Help with Homework
BigIdeasMath.com

Vocabulary and Concept Check

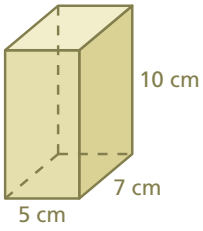
1. **CRITICAL THINKING** Explain how volume and surface area are different.
2. **REASONING** Will the formulas for volume work for rectangular prisms with decimal edge lengths? Explain.
3. **DIFFERENT WORDS, SAME QUESTION** Which is different? Find "both" answers.

How much does it take to fill the rectangular prism?

What is the capacity of the rectangular prism?

How much does it take to cover the rectangular prism?

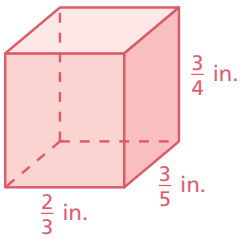
How much does the rectangular prism contain?



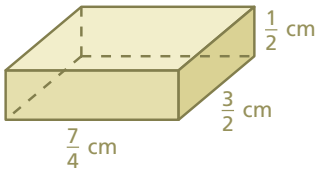
Practice and Problem Solving

Find the volume of the prism.

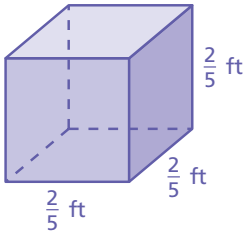
1 **4.**



5.



6.



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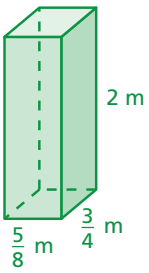

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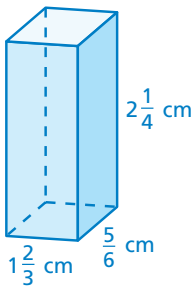
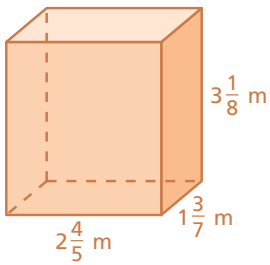
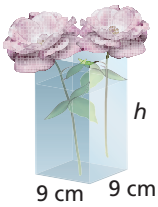


9.

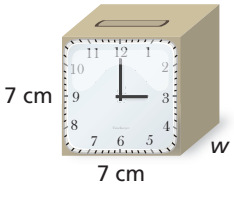


Write and solve an equation to find the missing dimension of the prism.

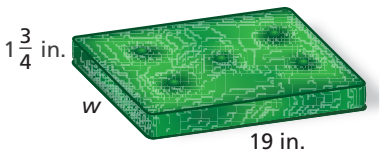
3 **10.** Volume = 1620 cm^3



11. Volume = 220.5 cm^3



12. Volume = 532 $in.^3$



Assignment Guide and Homework Check

Level	Day 1 Activity Assignment	Day 2 Lesson Assignment	Homework Check
Basic	4–6, 19–22	1–3, 7–15 odd	7, 9, 11, 13
Average	4–6, 19–22	1–3, 7–14, 16	7, 9, 11, 13, 14
Advanced	4–6, 19–22	1–3, 7–18	8, 10, 12, 14, 16

Common Errors

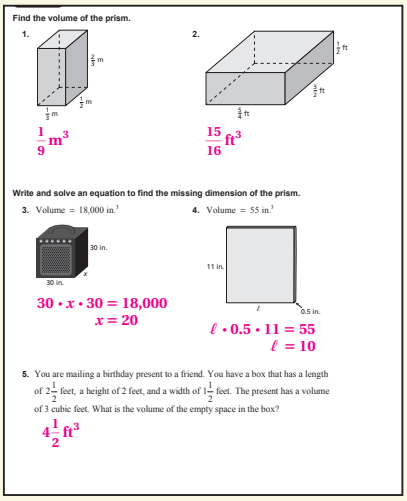
- **Exercises 4–9** Students may write the incorrect units. Remind them that volume has units cubed because there are three dimensions.
- **Exercises 10–13** Students may forget to simplify before solving for the variable and may lose or forget about one of the dimensions. For example:

$$\frac{1620}{9} = \frac{(9)(9)h}{9}$$
$$180 = h \quad ✗$$

$$1620 = (9)(9)h$$
$$\frac{1620}{81} = \frac{81h}{81}$$
$$20 = h$$

Remind them to simplify their equations before solving for a variable.

8.4 Record and Practice Journal



Find the volume of the prism.

1. $\frac{1}{9}$ m^3

2. $\frac{15}{16}$ ft^3

Write and solve an equation to find the missing dimension of the prism.

3. Volume = 18,000 in.^{3}

$30 \cdot x \cdot 30 = 18{,}000$
$x = 20$

4. Volume = 55 in.^{3}

$\ell \cdot 0.5 \cdot 11 = 55$
$\ell = 10$

5. You are mailing a birthday present to a friend. You have a box that has a length of $2\frac{1}{2}$ feet, a height of 2 feet, and a width of $1\frac{1}{2}$ feet. The present has a volume of 3 cubic feet. What is the volume of the empty space in the box?

$4\frac{1}{2}$ ft^3

Vocabulary and Concept Check

1. The volume of an object is the amount of space it occupies. The surface area of an object is the sum of the areas of all its faces.
2. yes; You just substitute the decimal edge lengths into the formula and multiply.
3. How much does it take to cover the rectangular prism?; 310 cm^2; 350 cm^3

Practice and Problem Solving

4. $\frac{3}{10}$ in.^{3}
5. $1\frac{5}{16}$ cm^3
6. $\frac{8}{125}$ ft^3
7. $\frac{15}{16}$ m^3
8. $3\frac{1}{8}$ cm^3
9. $12\frac{1}{2}$ m^3
10. $1620 = 9 \cdot 9 \cdot h$; 20 cm
11. $220.5 = 7 \cdot w \cdot 7$; 4.5 cm
12. $532 = 19 \cdot w \cdot 1\frac{3}{4}$; 16 in.

Practice and Problem Solving

13. See *Taking Math Deeper*.

14. $4096\frac{3}{4}$-centimeter cubes

15. See Additional Answers.

16. **a.** *Sample answer:* 297 $in.^3$

b. no; The container only holds 196 cubic inches.

17. 1152 cm^3

18. See Additional Answers.

Fair Game Review

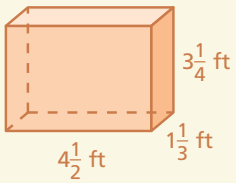
19. yes **20.** no

21. no **22.** C

Mini-Assessment

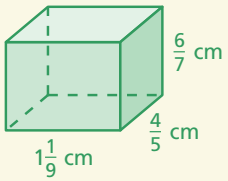
Find the volume of the rectangular prism.

1.



$19\frac{1}{2}$ ft^3

2.



$\frac{16}{21}$ cm^3

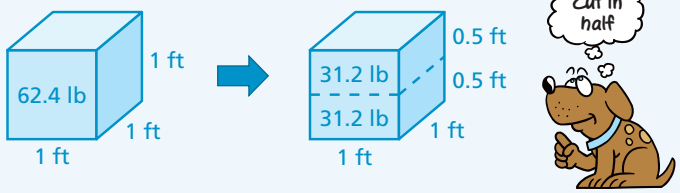
3. The volume of the cell phone is 75 cubic centimeters. Write and solve an equation to find the height of the cell phone. Round your answer to the nearest tenth. $75 = 10(4.7)h$; 1.6 cm

Taking Math Deeper

Exercise 13

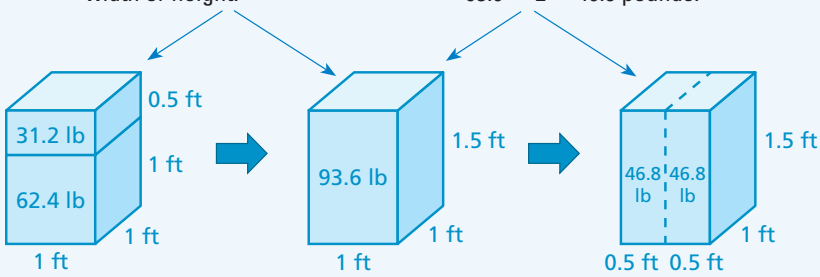
You can solve this problem visually by reasoning about cubes.

1 One cubic foot of water weighs about 62.4 pounds. You can visualize that a 1-foot cube fits in the fish tank, but the tank is 0.5 feet taller. So, imagine slicing a 1-foot cube of water in half horizontally. Each half weighs $62.4 \div 2 = 31.2$ pounds.



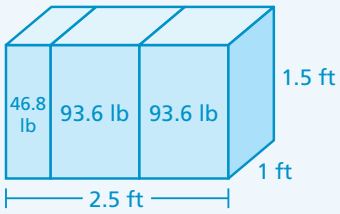
2 When you put one of these halves on top of a 1-foot cube, the new prism weighs $31.2 + 62.4 = 93.6$ pounds. It fits inside the tank without extra space along the width or height.

You can visualize that two of the 93.6-pound prisms fit inside the tank, but the tank is 0.5 feet *longer*. So, imagine slicing the prism in half vertically. Each half weighs $93.6 \div 2 = 46.8$ pounds.



3 The tank will hold two of the 93.6-pound prisms of water and one of the 46.8-pound prisms of water.

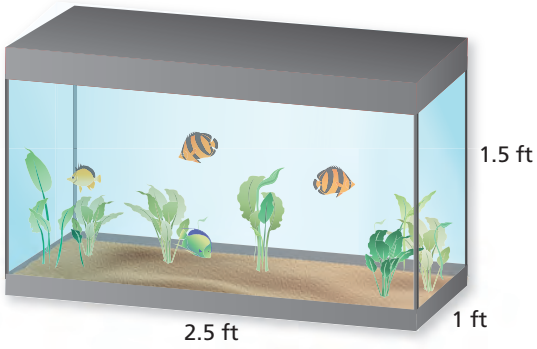
So, the fish tank can hold $46.8 + 93.6 + 93.6 = 234$ pounds of water when full.



Reteaching and Enrichment Strategies

If students need help. . .	If students got it. . .
Resources by Chapter • Practice A and Practice B • Puzzle Time Record and Practice Journal Practice Differentiating the Lesson Lesson Tutorials Skills Review Handbook	Resources by Chapter • Enrichment and Extension • Technology Connection Start the next section

13. FISH TANK One cubic foot of water weighs about 62.4 pounds. How many pounds of water can the fish tank hold when it is full?



14. CUBE How many $\frac{3}{4}$-centimeter cubes do you need to create a cube with an edge length of 12 centimeters?

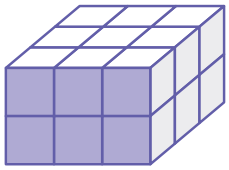
15. REASONING How many 1-inch cubes do you need to fill a cube that has an edge length of 1 foot? How can this result help you convert a volume from cubic inches to cubic feet? from cubic feet to cubic inches?

16. FOOD STORAGE

a. Estimate the amount of casserole left in the dish.

b. Will the casserole fit in the storage container? Explain your reasoning.

17. PROBLEM SOLVING The area of the shaded face is 96 square centimeters. What is the volume of the rectangular prism?



18. Project You have 1400 square feet of boards to use for a new tree house.

a. Design a tree house that has a volume of at least 250 cubic feet. Include sketches of your tree house.

b. Are your dimensions reasonable? Explain your reasoning.

Fair Game Review What you learned in previous grades & lessons

Tell whether the given value is a solution of the equation. *(Section 7.2)*

19. $x + 17 = 24;\ x = 7$

20. $\frac{x}{5} = 6;\ x = 35$

21. $x - 19 = 42;\ x = 21$

22. MULTIPLE CHOICE Which set of integers is ordered from least to greatest? *(Section 6.2)*

(A) $-1, 3, -5, -8, 12$

(B) $-1, 3, -5, -8, 12$

(C) $-4, -2, 1, 7, 10$

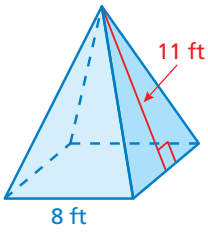
(D) $-14, -9, 6, -4, 2$

8.3–8.4 Quiz

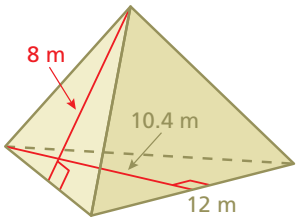
Check It Out
Progress Check
BigIdeasMath.com

Find the surface area of the pyramid. The side lengths of the base are equal. *(Section 8.3)*

1.

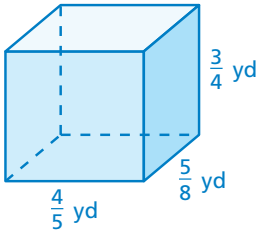


2.

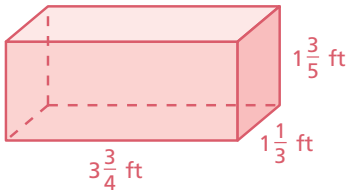


Find the volume of the prism. *(Section 8.4)*

3.

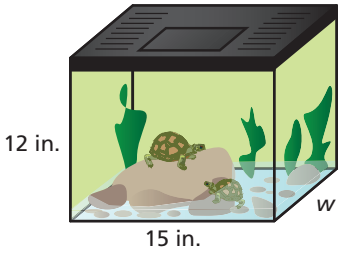


4.



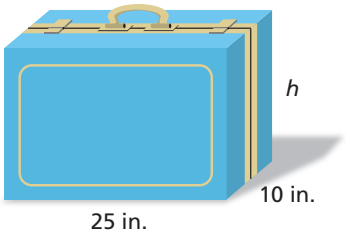
Write and solve an equation to find the missing dimension of the prism. *(Section 8.4)*

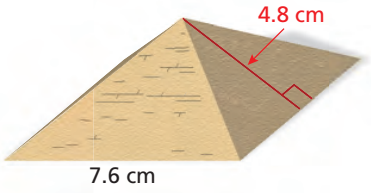
5. Volume = 1620 in.^{3}



6. Volume = 154 in.^{3}

7. Volume = 4250 in.^{3}

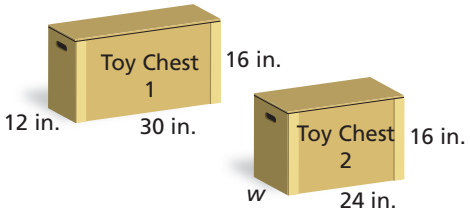




8. GREAT PYRAMID The Great Pyramid of Giza is a square pyramid. A gift shop sells miniature models of this pyramid. Find the surface area of the model shown at the left. *(Section 8.3)*

9. CUBE How many 1-inch cubes do you need to create a cube with an edge length of 7 inches? *(Section 8.4)*

10. TOY CHEST A toy company sells two different toy chests. The toy chests have different dimensions, but the same volume. What is the width w of Toy Chest 2? *(Section 8.4)*



Alternative Assessment Options

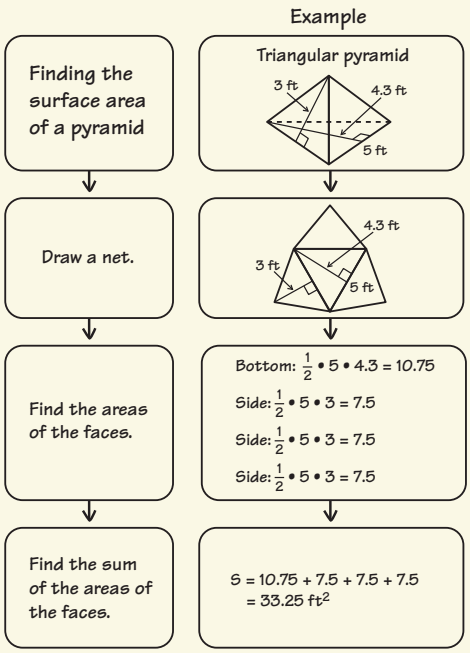
Math Chat Student Reflective Focus Question
Structured Interview Writing Prompt

Math Chat
Ask students to use their own words to summarize what they know about surface areas of rectangular prisms and pyramids, and volumes of rectangular prisms. Be sure that they include examples. Select students at random to present their summaries to the class.

Study Help Sample Answers

Remind students to complete Graphic Organizers for the rest of the chapter.

3.



4. Available at *BigIdeasMath.com*.

Reteaching and Enrichment Strategies

If students need help. . .	If students got it. . .
Resources by Chapter • Practice A and Practice B • Puzzle Time Lesson Tutorials *BigIdeasMath.com*	Resources by Chapter • Enrichment and Extension • Technology Connection Game Closet at *BigIdeasMath.com* Start the Chapter Review

Answers

1. 240 ft^2
2. 206.4 m^2
3. $\frac{3}{8} \text{ yd}^3$
4. 8 ft^3
5. $1620 = 15 \cdot w \cdot 12$; 9 in.
6. $154 = \ell \cdot 2 \cdot 11$; 7 in.
7. $4250 = 25 \cdot 10 \cdot h$; $h = 17$ in.
8. 130.72 cm^2
9. 343 cubes
10. 15 in.

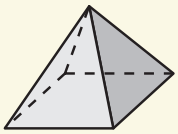
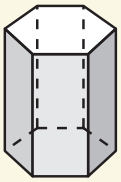
Technology for the Teacher

Online Assessment
Assessment Book
ExamView® Assessment Suite

For the Teacher
Additional Review Options

- *BigIdeasMath.com*
- Online Assessment
- Game Closet at *BigIdeasMath.com*
- Vocabulary Help
- Resources by Chapter

Answers

1. 6 faces, 12 edges, 8 vertices
2. 6 faces, 10 edges, 6 vertices
3. 
4. 

Review of Common Errors

Exercises 3 and 4

- Students may mix up the different types of solids. Remind them of the definition of each solid and give them a few real-life examples of each.

Exercises 5–7

- Students may sum the areas of only 3 of the faces of the rectangular prism instead of all 6. Remind them that a rectangular prism has 6 faces.

Exercises 11–13

- Students may forget to include the area of the base when finding the surface area of a pyramid. Remind them that when asked to find the surface area, the base is included.
- Students may add the wrong number of lateral face areas to the area of the base. Remind them that they must add the area of a lateral face as many times as there are sides on the base of the pyramid.

Exercises 14 and 15

- Students may write the units incorrectly, often writing square units instead of cubic units. Remind them that they are working in three dimensions, so the units are cubed. Give an example showing the formula as three units multiplied together. For example, write the volume of Exercise 14 as $V = \left(\frac{5}{2}\text{ ft}\right)\left(\frac{3}{2}\text{ ft}\right)\left(\frac{4}{3}\text{ ft}\right)$.

8 Chapter Review

Check It Out
Vocabulary Help
BigIdeasMath.com

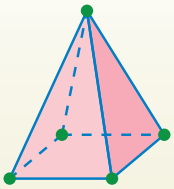
Review Key Vocabulary

solid, *p. 356*
polyhedron, *p. 356*
face, *p. 356*
edge, *p. 356*
vertex, *p. 356*
prism, *p. 356*
pyramid, *p. 356*
surface area, *p. 362*
net, *p. 362*
volume, *p. 374*

Review Examples and Exercises

8.1 Three-Dimensional Figures *(pp. 354–359)*

a. Find the number of faces, edges, and vertices of the solid.



The solid has 1 face on the bottom and 4 faces on the sides.

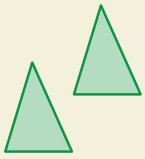
The faces intersect at 8 different line segments.

The edges intersect at 5 different points.

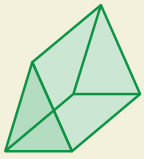
∴ So, the solid has 5 faces, 8 edges, and 5 vertices.

b. Draw a triangular prism.

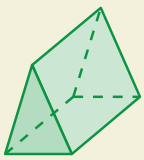
Draw identical triangular bases.



Connect corresponding vertices.



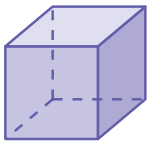
Change any *hidden* lines to dashed lines.



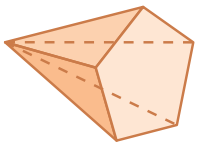
Exercises

Find the number of faces, edges, and vertices of the solid.

1.



2.



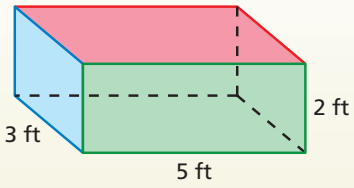
Draw the solid.

3. square pyramid

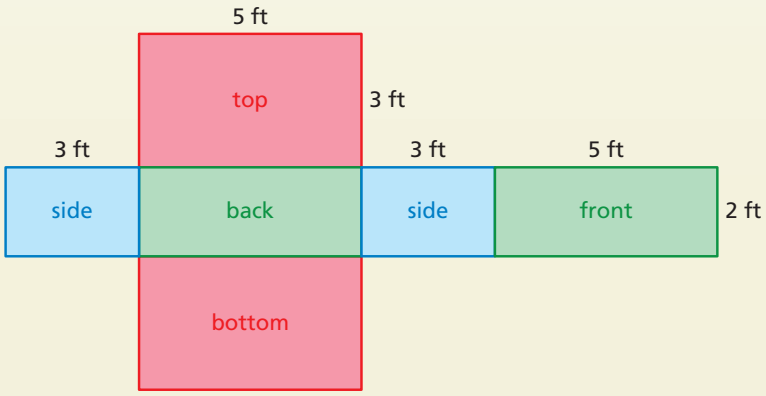
4. hexagonal prism

8.2 Surface Areas of Prisms *(pp. 360–365)*

Find the surface area of the rectangular prism.



Use a net to find the area of each face.



Top: $5 \cdot 3 = 15$ Front: $5 \cdot 2 = 10$ Side: $3 \cdot 2 = 6$

Bottom: $5 \cdot 3 = 15$ Back: $5 \cdot 2 = 10$ Side: $3 \cdot 2 = 6$

Find the sum of the areas of the faces.

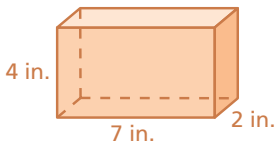
$$S = 15 + 15 + 10 + 10 + 6 + 6$$
$$= 62$$

∴ The surface area is 62 square feet.

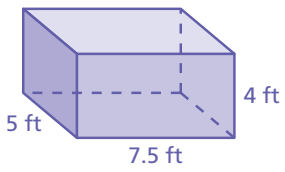
Exercises

Find the surface area of the prism.

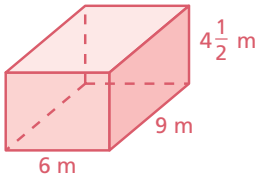
5.



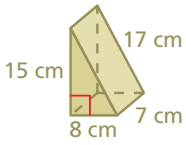
6.



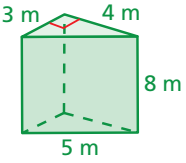
7.



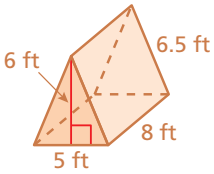
8.



9.



10.



Review Game

Surface Areas of Rectangular Prisms

Materials per Pair:

- paper
- pencils (colored pencils optional)

Directions:

Each group of four divides into teams of two. Each team competes with the other team. The class is directed to draw and label a rectangular prism with a predetermined surface area. For example, the teacher could say, "Draw and label a rectangular prism with a surface area of 50 square units." Each team then draws their prism, and calculates the surface area. Papers are exchanged within the group and teams check each other's work. The team whose correctly-drawn figure has an area that is closest to the area specified receives 1 point. If both teams are equally close, both teams receive 1 point. Play for a set amount of time.

Who Wins?

When time is up, the team with the most points wins.

For the Student
Additional Practice

- Lesson Tutorials
- Multi-Language Glossary
- Self-Grading Progress Check
- *BigIdeasMath.com*
  Dynamic Student Edition
  Student Resources

Answers

5. 100 in.^2

6. 175 ft^2

7. 243 m^2

8. 400 cm^2

9. 108 m^2

10. 174 ft^2

11. 16 in.^2

12. 147.6 m^2

13. 180.6 cm^2

14. 5 ft^3

15. $\frac{11}{18} \text{ cm}^3$

My Thoughts on the Chapter

What worked. . .

Teacher Tip

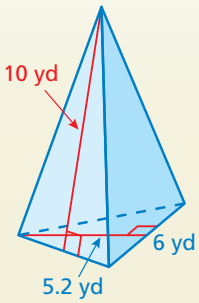
Not allowed to write in your teaching edition? Use sticky notes to record your thoughts.

What did not work. . .

What I would do differently. . .

8.3 Surface Areas of Pyramids *(pp. 368–373)*

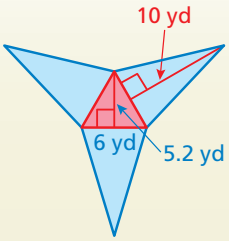
Find the surface area of the triangular pyramid.



Use a net to find the area of each face.

Bottom: $\frac{1}{2} \cdot 6 \cdot 5.2 = 15.6$ Side: $\frac{1}{2} \cdot 6 \cdot 10 = 30$

Side: $\frac{1}{2} \cdot 6 \cdot 10 = 30$ Side: $\frac{1}{2} \cdot 6 \cdot 10 = 30$



Find the sum of the areas of the faces.

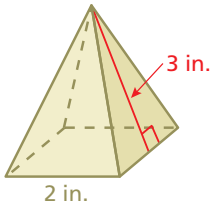
$S = 15.6 + 30 + 30 + 30 = 105.6$

∴ The surface area is 105.6 square yards.

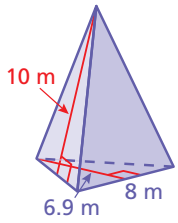
Exercises

Find the surface area of the pyramid. The side lengths of the base are equal.

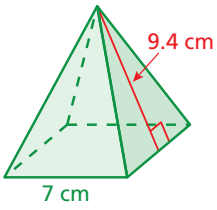
11.



12.



13.



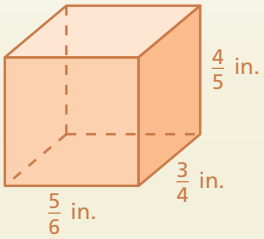
8.4 Volumes of Rectangular Prisms *(pp. 374–379)*

Find the volume of the prism.

$V = \ell wh$ Write formula for volume.

$= \frac{5}{6}\left(\frac{3}{4}\right)\left(\frac{4}{5}\right)$ Substitute values.

$= \frac{1}{2}$ Multiply.

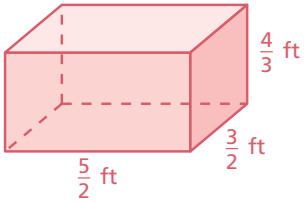


∴ The volume is $\frac{1}{2}$ cubic inch.

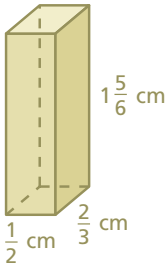
Exercises

Find the volume of the prism.

14.



15.

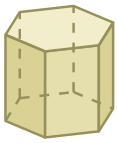


8 Chapter Test

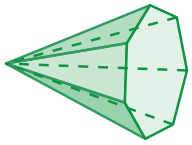
Check It Out
Test Practice
BigIdeasMath.com

Find the number of faces, edges, and vertices of the solid.

1.

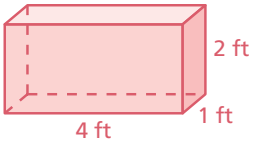


2.

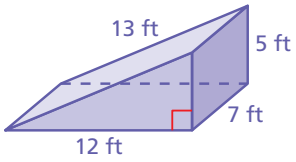


Find the surface area of the prism.

3.

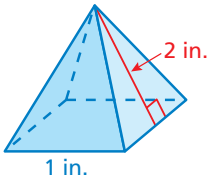


4.

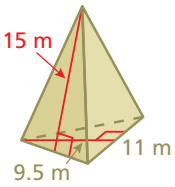


Find the surface area of the pyramid. The side lengths of the base are equal.

5.

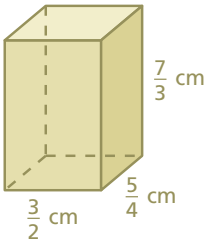


6.

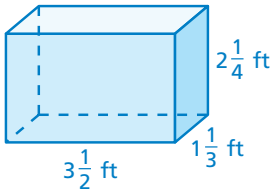


Find the volume of the prism.

7.

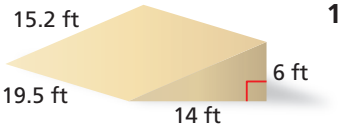


8.



9. DRAWING A SOLID Draw an octagonal prism.

10. DVD COLLECTION You are wrapping the boxed DVD collection as a present. What is the least amount of wrapping paper needed to wrap the box?



11. SKATEBOARD RAMP A quart of paint covers 80 square feet. How many quarts should you buy to paint the ramp with two coats? (Assume you will not paint the bottom of the ramp.)

12. CUBE A cube has an edge length of 4 inches. You double the side lengths. How many times greater is the volume of the new cube?

Test Item References

Chapter Test Questions	Section to Review	Common Core State Standards
1, 2, 9	8.1	6.G.4
3, 4, 10, 11	8.2	6.G.4
5, 6	8.3	6.G.4
7, 8, 12	8.4	6.G.2

Test-Taking Strategies

Remind students to quickly look over the entire test before they start so that they can budget their time. This test is very visual and requires that students remember many terms. It might be helpful for them to jot down some of the terms on the back of the test before they start.

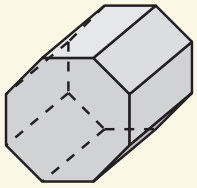
Common Errors

- **Exercise 3** Students may sum the areas of only 3 of the faces of the rectangular prism instead of all 6. Remind them that a rectangular prism has 6 faces.
- **Exercises 5 and 6** Students may forget to include the area of the base or add the wrong number of lateral face areas when finding the surface area of a pyramid. Remind them that the base is included as part of the surface area, and that they must add the area of each lateral face.
- **Exercises 7 and 8** Students may write the units incorrectly, often writing square units instead of cubic units. Remind them that they are working in three dimensions, so the units are cubed.

Reteaching and Enrichment Strategies

If students need help. . .	If students got it. . .
Resources by Chapter • Practice A and Practice B • Puzzle Time Record and Practice Journal Practice Differentiating the Lesson Lesson Tutorials *BigIdeasMath.com* Skills Review Handbook	Resources by Chapter • Enrichment and Extension • Technology Connection Game Closet at *BigIdeasMath.com* Start Cumulative Assessment

Answers

1. 8 faces, 18 edges, 12 vertices
2. 8 faces, 14 edges, 8 vertices
3. 28 ft^2
4. 270 ft^2
5. 5 $in.^2$
6. 299.75 m^2
7. $\frac{35}{8}$ cm^3, or $4\frac{3}{8}$ cm^3
8. $\frac{21}{2}$ ft^3, or $10\frac{1}{2}$ ft^3
9. 
10. 138 $in.^2$
11. 13 quarts of paint
12. 8 times greater

Technology for the Teacher

Online Assessment
Assessment Book
ExamView® Assessment Suite

Test-Taking Strategies

Available at *BigIdeasMath.com*

After Answering Easy Questions, Relax
Answer Easy Questions First
Estimate the Answer
Read All Choices before Answering
Read Question before Answering
Solve Directly or Eliminate Choices
Solve Problem before Looking at Choices
Use Intelligent Guessing
Work Backwards

About this Strategy

When taking a multiple choice test, be sure to read each question carefully and thoroughly. When taking a timed test, it is often best to skim the test and answer the easy questions first. Be careful that you record your answer in the correct position on the answer sheet.

Answers

1. B
2. H
3. C
4. F

Technology for the Teacher

Performance Tasks
Online Assessment
Assessment Book
ExamView® Assessment Suite

Item Analysis

1. **A.** The student misinterprets "never been above" to mean "always been below."

   B. Correct answer

   C. The student confuses less than and greater than symbols, and uses strict inequality inappropriately.

   D. The student confuses less than and greater than symbols.

2. **F.** The student does not follow the order of operations and adds 6 to $3 \cdot 4^2$ instead of dividing 6 by 2.

   G. The student does not follow the order of operations and adds before multiplying and dividing.

   H. Correct answer

   I. The student does not follow the order of operations and evaluates the expression as $[(3 \cdot 4)^2 + 6] \div 2$

3. **A.** The student multiplies the volume by $\frac{1}{2}$.

   B. The student calculates the surface area instead of the volume.

   C. Correct answer

   D. The student multiplies the volume by 2.

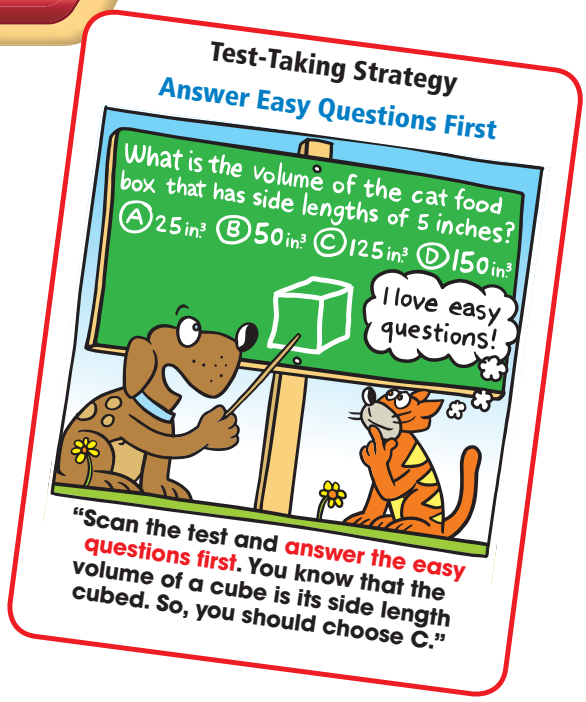
4. **F.** Correct answer

   G. The student adds 60 and 8 together.

   H. The student interchanges the roles of 60 and 8 in the equation.

   I. The student adds 8 and y together instead of multiplying them.

8 Cumulative Assessment



1. The temperature in a town has never been above 38 degrees Fahrenheit. Let t represent the temperature, in degrees Fahrenheit. Which inequality represents the temperature in the town?

A. $t < 38$ **C.** $t > 38$

B. $t \leq 38$ **D.** $t \geq 38$

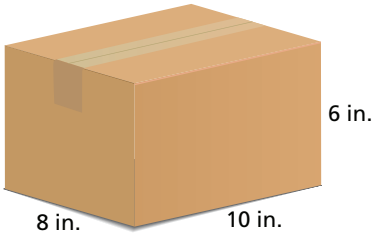
2. Which number is equivalent to the expression below?

$$3 \cdot 4^2 + 6 \div 2$$

F. 27 **H.** 51

G. 33 **I.** 75

3. What is the volume of the package shown below?



A. 240 in.^{3} **C.** 480 in.^{3}

B. 376 in.^{3} **D.** 960 in.^{3}

4. A housing community started with 60 homes. In each of the following years, 8 more homes were built. Let y represent the number of years that have passed since the first year, and let n represent the number of homes. Which equation describes the relationship between n and y?

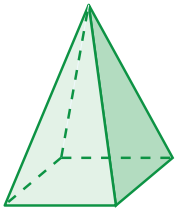
F. $n = 8y + 60$ **H.** $n = 60y + 8$

G. $n = 68y$ **I.** $n = 60 + 8 + y$

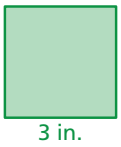
5. What is the value of m that makes the equation below true?

$$4m = 6$$

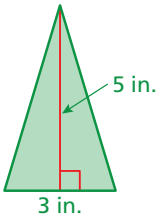
6. A square pyramid is shown below.



The square base and one of the triangular faces of the square pyramid are shown below with their dimensions.



Square Base



A Triangular Face

What is the total surface area of the square pyramid?

A. 16.5 in.^{2}

B. 31.5 in.^{2}

C. 39 in.^{2}

D. 69 in.^{2}

7. A wooden box has a length of 12 inches, a width of 6 inches, and a height of 8 inches.

Think Solve Explain

Part A Draw and label a rectangular prism with the dimensions of the wooden box.

Part B What is the surface area, in square inches, of the wooden box? Show your work.

Part C You have a 2-ounce sample of wood stain that covers 900 square inches. Is this enough to give the entire box two coats of stain? Show your work and explain your reasoning.

Item Analysis (continued)

5. Gridded Response: Correct answer: 1.5 or $\frac{3}{2}$

Common Error: The student subtracts 4 from 6 and gets an answer of 2.

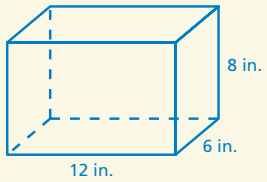
6. A. The student includes the area of only one triangular face.

B. The student includes the area of only three triangular faces.

C. Correct answer

D. The student does not multiply by $\frac{1}{2}$ when determining the area of a triangular face.

7. 4 points The student demonstrates a thorough understanding of the shape and attributes of a rectangular prism. The student draws and correctly labels the dimensions of the box and calculates the surface area as 432 square inches. The student is able to explain why the 2-ounce sample of stain is enough for two coats. The student shows accurate, complete work for all parts and provides clear and complete explanations.



3 points The student demonstrates an understanding of the shape and attributes of a rectangular prism, but the student's work and explanations demonstrate an essential but less than thorough understanding.

2 points The student demonstrates a partial understanding of the shape and attributes of a rectangular prism. The student's work and explanations demonstrate a lack of essential understanding.

1 point The student demonstrates very limited understanding of the shape and attributes of a rectangular prism. The student's response is incomplete and exhibits many flaws.

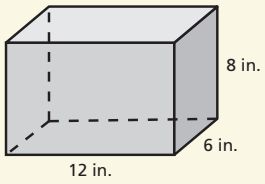
0 points The student provided no response, a completely incorrect or incomprehensible response, or a response that demonstrates insufficient understanding of the shape and attributes of a rectangular prism.

Answers

5. 1.5, or $\frac{3}{2}$

6. C

7. *Part A*



Part B

Surface Area = Top + Bottom + Front + Back + Side + Side

$= 12 \cdot 6 + 12 \cdot 6 + 12 \cdot 8 + 12 \cdot 8 + 6 \cdot 8 + 6 \cdot 8$

$= 432$ square inches

Part C yes; $900 \div 432 \approx 2.1$, so you should have just enough to cover the box twice.

Answers

8. I

9. 6

10. A

Item Analysis (continued)

8. **F.** The student multiplies the two lengths instead of dividing.

G. The student subtracts the two lengths instead of dividing.

H. The student divides 6 by 3, and then divides 32 by the result.

I. Correct answer

9. **Gridded Response:** Correct answer: 6

Common error: The student adds 1 to 2 in the top row to get 3, or the student multiplies 2 by 2 to get 4 because the second entry is double the first entry.

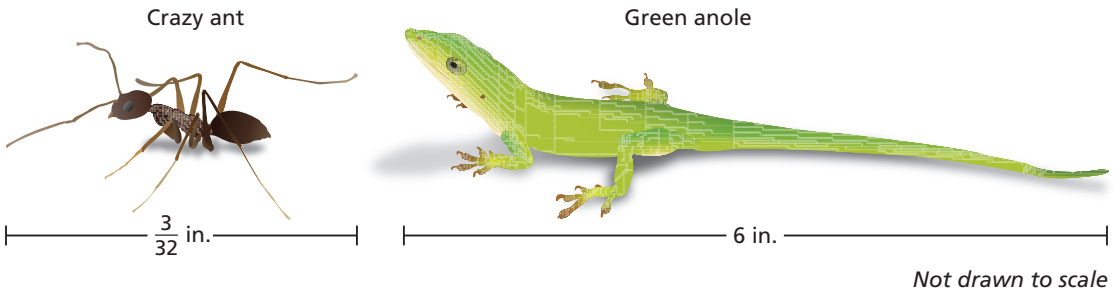
10. **A.** Correct answer

B. The student counts all squares with any shading.

C. The student uses $A = bh$ when finding the area of the triangle.

D. The student multiplies the height of the figure by the base of the triangle.

8. A biologist measures the lengths of a crazy ant and a green anole that he has in his laboratory. His measurements are shown below.



Not drawn to scale

The length of the green anole is how many times greater than the length of the crazy ant?

F. $\frac{9}{16}$

G. $5\frac{29}{32}$

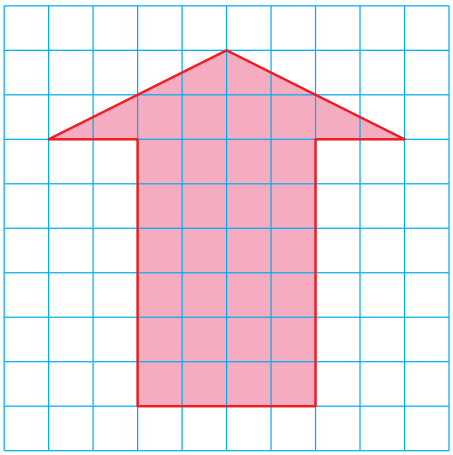
H. 16

I. 64

9. What is the missing value in the ratio table?

Castles	1	2		12
Towers	4	8	24	48

10. What is the area of the shaded figure shown below?



A. 32 units^2

B. 36 units^2

C. 40 units^2

D. 64 units^2