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8 Surface Area and Volume

Dear Family,

In this chapter, your student is learning about the surface area and volume of solid shapes such as cubes and pyramids. You can help your student learn to visualize how changes in shape affect the surface area and volume of an object using various boxes from the pantry and pictures of pyramids.

Collect some boxes from the pantry. You should have at least four different sizes.

- Compare two boxes of different sizes. Estimate how much more the bigger box holds. How do the dimensions of the two boxes compare?
- Use two boxes of the same size. What happens to the volume when you put them together to make one larger box? What happens to the surface area? Does your answer change depending on which sides are placed together? (The volume doubles. The two sides of the boxes that are touching are no longer on the surface, so the surface area of the doubled box would have less than twice the area as the single box. How much less depends on how large the "removed" side is—removing a smaller side leads to a larger surface area.)
- Try using three or more boxes of the same size. Arrange them to model one larger box. Estimate out how the volume and surface area change.

Do you have any pyramid shaped items lying around your house? If not, find a picture or two of different sizes of pyramids and compare them. Take notice of the base and sides of the pyramid.

- How is a pyramid different than a box? Compare the surface area and volume of a pyramid and box. How are they the similar? How are they different?
- If a box and a pyramid have the same base dimensions and height, which would have the greater surface area? Which would have the greater volume?

Enjoy experimenting!

Capítulo 8 Área de superficie y volumen

Estimada familia,

En este capítulo, su estudiante aprenderá sobre el área de la superficie y el volumen de figuras sólidas tales como cubos y pirámides. Usted puede ayudar a su estudiante a visualizar cómo los cambios en la figura de un objeto afectan el área de su superficie y su volumen, usando varias cajas de su alacena e ilustraciones de pirámides.

Reúnan algunas cajas de su alacena. Deberán conseguir al menos cuatro tamaños diferentes.

- Comparen dos cajas de diferentes tamaños. Estimen cuánto más espacio tiene la caja más grande. ¿Qué diferencias hay entre las dimensiones de las dos cajas?
- Usen dos cajas del mismo tamaño. ¿Qué pasa con el volumen cuando las juntan para formar una caja más grande? ¿Qué sucede con el área de su superficie? ¿Cambia su respuesta dependiendo de los lados que se junten? (El volumen se duplica. Los lados de las cajas que se tocan ya no están en la superficie, así que el área de la superficie de la caja doble sería menor que el doble del área de la caja sola. Cuánto menos dependerá del tamaño del lado que "retiren"—si quitan un lado más pequeño el resultado será un área de superficie mayor.)
- Intenten usando tres cajas o más del mismo tamaño. Organícenlas para formar una caja más grande. Estimen cómo cambian el volumen y el área de su superficie.

¿Tienen objetos en forma de pirámide en su casa? De no ser así, busquen una o dos ilustraciones de pirámides de diferentes tamaños para compararlas. Noten la base y los lados de la pirámide.

- ¿En qué se diferencia una pirámide de una caja? Comparen el área de la superficie y el volumen de la pirámide y la caja. ¿En qué se parecen? ¿En qué se diferencian?
- Si una caja y una pirámide tienen la misma altura y dimensiones en la base, ¿cuál tendría una superficie de área mayor? ¿Cuál tendría el volumen mayor?

iDisfruten experimentando!



Explain what you think the difference is between a two-dimensional figure and a three-dimensional figure.



Determine if the figure is three-dimensional.











Explain how to find the surface area of a three-dimensional figure that is made up of cubes.



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









8.1 Practice A

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



2.	\square	2	7		
			Ł	6	

Draw the solid.

3. Square pyramid

4. Right triangular prism

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





7. 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 side views of both solids in parts (a) and (b).

8.1 Practice B

Draw the solid.

- **1.** Octagonal pyramid
- 2. Octagonal prism

4.

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





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



6. Two of the three views of a solid are shown.



- **a.** What is the greatest surface area of the solid, in square units?
- **b.** What is the least surface area of the solid, in square units?
- **c.** Draw the side views of both solids in parts (a) and (b).

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Resources by Chapter

8.1 Enrichment and Extension

A Solid Challenge

You have 12 cubes with side lengths of 1 unit. You want to design solids with different surface areas using these cubes. In each solid, cubes must be joined on faces, not on edges only. Translations, reflections, and rotations do not count as different solids. (See Activity 2 from Section 8.1 in your textbook for an example.) You will need dot paper to draw the solids. Your teacher may even have cubes that you can use to actually build your solids.

- 1. Consider the solids that can be made with six cubes.
 - **a.** How many different surface areas are possible? List them.
 - **b.** Draw two different solids for each surface area.
- 2. Consider the solids that can be made with eight cubes.
 - **a.** How many different surface areas are possible? List them.
 - **b.** There is one surface area for which only one solid can be drawn. Which one is it? Draw the solid that has this surface area.
 - **c.** Draw two different solids for each of the remaining surface areas.
- **3.** Describe how to make solids with more or less surface area.
- **4.** Describe and draw the solid that has the least surface area possible using all 12 blocks. Then describe and draw the solid that has the greatest surface area possible using all 12 blocks.
- **5.** Predict how many different surface areas are possible with all 12 cubes. Explain your reasoning. In making your prediction, look back at what surface areas were possible using six and eight blocks as well as what surface areas were not possible. Make a list of the surface areas that you predict to be possible with all 12 cubes.



What Do You Get When You Cross An Elephant With A Fish?

Write the letter of each answer in the box containing the exercise number.

Identify the solid that is described.

- **1.** One pentagonal base and five lateral faces that are triangles.
- **2.** One rectangular base and four lateral faces that are triangles
- **3.** Two parallel, triangular bases and three lateral faces that are rectangles
- **4.** Two parallel, pentagonal bases and five lateral faces that are rectangles
- **5.** Two parallel, square bases and four lateral faces that are squares
- **6.** Two parallel, rectangular bases and four lateral faces that are rectangles
- **7.** One triangular base and three lateral faces that are triangles

Determine the correct number.

- 8. The number of vertices on a cube
- **9.** The number of lateral faces on a triangular prism
- **10.** The number of lateral faces on a pentagonal prism
- **11.** The number of vertices on a pentagonal pyramid
- **12.** The number of vertices on a triangular pyramid
- **13.** The number of edges on a rectangular prism
- **14.** The number of vertices on a pentagonal prism



Answers for Exercises 1–7

- S. Pentagonal Prism
- **G.** Triangular Pyramid
- N. Pentagonal Pyramid
- **R.** Rectangular Prism
- I. Rectangular Pyramid
- M. Cube
- **U.** Triangular Prism

Answers for Exercises 8–14

- **K.** 6
- I. 8
- **T.** 12
- **S.** 5
- **M**. 4
- **w**. 10
- **N.** 3



How are the concepts of *area* and *surface area* similar? How are they different?

What kind of units are used to measure surface area?



Find the area.





What is a rectangular prism? Sketch a rectangular prism.

Draw a two-dimensional representation of your sketch. Explain to a partner how to find the surface area of your prism.



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



8.2 Practice A

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





Find the surface area of the prism.



7. Using a ruler, measure the dimensions of a tissue box that is in the shape of a rectangular prism. Assume that the entire tissue box is made of cardboard. How many square inches of cardboard were used to create the tissue box? (Ignore any overlap in the cardboard.)

8.2 Practice B

Find the surface area of the prism.



- 7. You are baking a cake. The recipe calls for a cake pan that is 9 inches by 11 inches by 2 inches. You have a cake pan that is 10 inches by 10 inches by 2 inches.
 - **a.** What is the volume of the recipe's cake pan?
 - **b.** What is the volume of your cake pan?
 - **c.** What is the surface area of the recipe's cake pan? (The top of the cake pan is open.)
 - **d.** What is the surface area of your cake pan? (The top of the cake pan is open.)
 - **e.** Based upon your answers above, is it okay to use your cake pan for this recipe? Explain.

8.2 Enrichment and Extension

Boxing Up Basketballs and Cereal

Olivia works in the design department of a packaging company. Help her by answering the following questions.

- 1. Olivia has to design a plastic shipping container that will hold 12 basketballs in individual boxes. The basketballs have a radius of 4.5 inches and fit exactly in their individual boxes that are cubes.
 - **a.** Give the dimensions (in inches) of 4 different plastic shipping containers that would fit the boxes exactly. Two containers with the same dimensions in a different order do not count as different containers. Find the surface area of each of your designs.
 - **b.** Divide each surface area from part (a) by 144 to convert it to square feet. Explain why you divide by 144.
 - **c.** Olivia's company made 100 containers one month with the design that uses the most plastic. The next month, they made 100 containers with the design that uses the least plastic. How much plastic (in square feet) did the company save in the second month?
- Next, Olivia was asked to consider some new designs for a cereal box that was originally 7.7 inches by 2.6 inches by 11.8 inches. Each of the new designs will hold roughly the same amount of cereal as the original.
 - **a.** Find how much cardboard (in square inches) it would take to make the original cereal box as well as each of the new designs.



- **b.** Olivia's company made 1000 cereal boxes with the design that uses the least cardboard. How many square feet of cardboard would they save compared to making 1000 of the original boxes?
- **c.** What are some advantages to the design with the least surface area? disadvantages? What design do you think Olivia should recommend? Explain your reasoning.
- **3.** Look for a pattern in Exercises 1 and 2. Predict what kind of rectangular prism has the least surface area.



What Do You Call A Person Who Makes Faces All Day Long?

Write the letter of each answer in the box containing the exercise number.

Find the surface area of the prism.

- 1. A cube that has side lengths measuring 9 inches.
- 2. A cube that has side lengths measuring 7 inches.
- **3.** A rectangular prism that measures 6 inches by 8 inches by 4 inches.
- **4.** A rectangular prism that measures 3 inches by 5 inches by 10 inches.
- **5.** A rectangular prism that measures 7 inches by 7 inches by 4 inches.
- **6.** A rectangular prism that measures 3 inches by 6 inches by 12 inches.
- **7.** A rectangular prism that measures 2 inches by 5 inches by 8 inches.
- **8.** A triangular prism with bases that are right triangles measuring 5 inches by 12 inches by 13 inches. The height of the prism is 2 inches.
- **9.** A triangular prism with bases that are right triangles measuring 7 inches by 24 inches by 25 inches. The height of the prism is 3 inches.
- **10.** A triangular prism with bases that have a base of 16 inches, the legs are 10 inches, and a height of 6 inches. The height of the prism is 11 inches.
- **11.** A triangular prism with bases that have a base of 18 inches, the legs are 15 inches, and a height of 12 inches. The height of the prism is 7 inches.

1	8	5	2	11	7	4	9	6	3	10

An	swers
М.	190 in. ²
Ε.	208 in. ²
C.	552 in. ²
L.	210 in. ²
R.	492 in. ²
C.	120 in. ²
Κ.	132 in. ²
О.	294 in. ²
Α.	486 in. ²
Α.	336 in. ²
K.	252 in. ²



Explain to a partner how to find the area of a triangle.



Find the area of the triangle.





You need to build a pyramid out of wood for a school project. The pyramid needs to be painted. Explain how to determine how many quarts of paint needed to cover all sides and the bottom of your pyramid.



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









8.3 Practice A

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













7. The top of a lantern is shaped like a square pyramid. The side lengths of the base are equal. Find the surface area of the top of the lantern.



8.3 Practice B

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



7. The surface area of a triangular pyramid is 96.6 square centimeters. The side lengths of the base are 6 centimeters, and the height of the base is 5.2 centimeters. What is the slant height?



8.3 Enrichment and Extension

Square Pyramids

The Great Pyramid in Giza, Egypt, was constructed by the Ancient Egyptians. The Pyramid was built as a tomb for Pharaoh Khufu.

Use the dimensions of the Great Pyramid to answer the questions.

- **1.** Consider the base of the Great Pyramid.
 - **a.** What type of quadrilateral forms the base of the Great Pyramid?



- **b.** What is the area of the base of the Great Pyramid?
- 2. The surface area of a square pyramid can be calculated using the formula SA = b² + 2 b ℓ, where b is the length of the base and ℓ is the slant height of the pyramid.
 - **a.** Find the surface area of the Great Pyramid.
 - **b.** What does the slant height of the Great Pyramid describe?
- **3.** You are constructing a scale model of the Great Pyramid for school.
 - **a.** Each dimension of the model should be $\frac{1}{215}$ the size of the actual Great Pyramid. What are the dimensions of the model? Round your answer to the nearest hundredth.
 - **b.** You find an old piece of plywood on which you could construct the model. The piece of plywood measures 3 feet by 4 feet. Will the plywood work as a base for your model? Explain your reasoning.
 - c. What is the surface area of your model pyramid?
 - **d.** How does the surface area of the model compare to the surface area of the Great Pyramid?
- **4.** The Louvre is an art museum in Paris, France. The Louvre is flanked by a glass square pyramid that is 21.6 meters tall, 35.5 meters wide, and has a slant height of 28.2 meters. Find the surface area of the Louvre's pyramid.

Date



How Much Is A Skunk Worth?

Write the letter of each answer in the box containing the exercise number.







2	5	1	7	6	3	4	8



When you hear the word "volume," what do you think of?

Give an example of when you might want to know the volume of an object.

What kind of units are used to measure volume?



Multiply. Simplify if necessary.

1. $4 \times 8 \times 2$ **2.** $3 \times 9 \times 4$
3. $10 \times 10 \times 15$ **4.** $7 \times 6 \times 5$
5. $\frac{1}{2} \times \frac{2}{3} \times \frac{1}{4}$ **6.** $\frac{2}{3} \times \frac{3}{4} \times \frac{1}{5}$



Tell whether volume applies to the situation.

- **A.** Wrapping paper used to wrap a gift
- **B.** Milk poured into a glass
- **C.** Air needed to blow up a ball
- **D.** Fabric for making a quilt
- **E.** How much will fit in a suitcase

Describe another situation in which volume would apply.



Find the volume of the prism.



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Find the volume of the prism.



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







- **9.** An office cubicle measures seven feet by eight feet with a five-foot wall. What is the volume of the cubicle?
- **10.** A cube with side length 4 centimeters is 25% full of sand. What is the volume of the sand?
- **11.** A cube has sides of length 2 meters. Explain what happens to the volume of the cube if the length of the sides is doubled.
- **12.** The area of the shaded face is 72 square inches. What is the volume of the rectangular prism?

, 30 cm



8.4

Practice B

- **1.** A storage trunk is 3 feet long and 1 foot wide. The height of the trunk is $1\frac{1}{4}$ feet. What is the volume of the trunk?
- **2.** A filing cabinet is 35 centimeters by 70 centimeters by 115 centimeters. The bottom drawer is 30% of the volume of the filing cabinet. What is the volume of the bottom drawer?

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

- **3.** Volume = 1 km^3 **4.** Volume = $23\frac{1}{25} \text{ ft}^3$ **5.** Volume = $\frac{9}{125} \text{ mi}^3$ **6.** $\frac{12}{125} \text{ mi}^3$ **7.** $\frac{1}{12} \text{ ft}^3$ **7.** $\frac{16}{25} \text{ mi}^3$ **7.** $\frac{16}{25} \text{ mi}^3$ **7.** $\frac{16}{25} \text{ mi}^3$
- 6. Volume = 220.8 mm³ 7. Volume = $4\frac{1}{2}$ in.³ 8. Volume = 5 cm³ 9.6 mm
 9.6 mm $u^{2\frac{1}{4}}$ in. $h^{1\frac{1}{3}}$ cm
- **9.** A cellular phone is in the shape of a rectangular prism. The height of the phone is 6 millimeters, and the width is 50 millimeters. The volume is 22,500 cubic millimeters. What is the length of the cellular phone?
- **10.** A cube is made up of a group of smaller, identical cubes. The cube has a side length of three inches. What is the volume of one of the smaller cubes?



- **11.** A calendar that has one page per day is 7 inches long, 7 inches wide, and 2 inches high. What is the volume of one page of the calendar? Round your answer to the nearest thousandth.
- **12.** What happens to the volume of a rectangular prism if you multiply the length, the width, and the height by 2?

8.4 **Enrichment and Extension**

Displacement

water. When the metal prism is placed in the tank, it is $\frac{3}{5}$ full. Find the height h of the metal prism.



1. A rectangular tank is $\frac{1}{2}$ filled with **2.** A rectangular tank is $\frac{3}{4}$ filled with water. When the metal prism is placed in the tank, it is $\frac{79}{100}$ full. Find the width w of the metal prism.



3. A tank is $\frac{5}{8}$ filled with water. When the metal cube is placed in the tank, it is $\frac{3}{4}$ full. Use the guess, check, and revise strategy to find the dimensions of the cube.



4. A tank is $\frac{1}{2}$ filled with water. The water level rises when four 5-inch metal cubes are placed in the tank. Find the height of the water level before and after the cubes



are placed in the tank.



What Did The Necktie Say To The Hat?

A	В	С	D	E	F
G	н				

Complete each exercise. Find the answer in the answer column. Write the word under the answer in the box containing the exercise letter.



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



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Chapter
8Technology Connection
8For use after Section 8.4

Understanding Internet Sources

The Internet is a free and open global forum that allows people to access information quickly and easily; but the openness of the Internet means anyone can write their opinions as fact, misrepresent information, or present outright wrong information. To use the Internet correctly, you need to validate and evaluate the information you find.

The information in a website address contains *meta-web* information. *Meta* means "about" so you can tell a lot about the source of the information from the Internet address. Let's look at an Internet address:



http://www.math.union.edu/~dpvc/courses/2008-09/MTH053-FA08/policies/hw.html

In Exercises 1–5, use the URLs.

http://www.nctm.org/

http://academic.reed.edu/math/faculty.html

http://www.k12.hi.us/~tashimin/grading.html

http://www.bigideaslearning.com/

http://people.reed.edu/~davidp/111/

- **1.** Which site(s) are hosted by an institution of higher learning? What college hosts these sites? Which of these pages was created by the college? How do you know?
- **2.** Which site(s) are hosted by a K-12 school? What state is the school in? What is posted at this site? Who posted this information?
- 3. Which site(s) are hosted by an organization? a company? How do you know?
- **4.** Which sites represent information created by one person? If you wanted to learn more about the author of one of these pages, what could you do?
- **5.** Look at some of the websites you use as sources of information. Do some provide more reliable information than others? Explain. Give some examples.