Chapter 9

Chapter 9
Surface Area and Volume

Dear Family,

Does your family have an aquarium? Aquatic creatures make beautiful and interesting pets, and allergies are rarely an issue.

Fish can live in simple aquariums or more complex ones. The type of aquarium you choose will determine the supplies you will need, but all aquariums need a clean base of gravel. The gravel provides a place for beneficial microorganisms to grow. These organisms will help keep your aquarium clean and your animals and plants healthy. Plants help provide oxygen in the water and use some of the animal waste to keep the aquarium cleaner. You will also need clean water that is free of chlorine.

To set up your aquarium, ask your student to help make a plan. Here are some things you need to consider.

- Multiply the area of the base of your tank by the height to find the volume of the tank. This will give you an estimate of how much de-chlorinated water you need to have on hand. Tank sizes are often calculated in terms of gallons—work with your student to convert the volume of water to gallons.

- Find the amount of gravel you need by multiplying the height of the gravel in the tank by the area of the base of the aquarium. Make sure your gravel is rinsed and free of chemicals before putting it in the aquarium.

- Use the volume of water in the tank and the surface area of the tank to find out how many plants and animals your aquarium can safely hold. Local hobbyists and aquarium shops can help you figure out how to stock your aquarium.

You will need to change the water in your aquarium regularly (about a third of the volume every week or so). How much de-chlorinated water will you need to have on hand? Depending on the animals and plants you choose, you may also have to use a filter system and a heater.

In no time at all you'll be enjoying your new pets!

Capítulo 9 Area de la superficie y volumen

Estimada Familia:

¿Hay un acuario en su familia? Las criaturas acuáticas son mascotas hermosas e interesantes, y casi no generan problemas de alergias.

Los peces pueden vivir en acuarios simples o complejos. El tipo de acuario que elija determinará los suministros que necesita, pero todos los acuarios necesitan una base limpia de grava. La grava proporciona un lugar para el crecimiento de microorganismos beneficiosos. Estos organismos ayudarán a mantener limpio su acuario y saludables a sus plantas y animales. Las plantas pueden proporcionar oxígeno en el agua y usar algo de los desechos animales para mantener el acuario más limpio. También necesitará agua limpia que no contenga cloro.

Para armar un acuario, pida a su estudiante que le ayude a hacer un plan. He aquí algunas cosas que tendrá que tomar en cuenta:

- Multipliquen el área de su tanque por el alto para encontrar el volumen del tanque. Esto les dará un cálculo de cuánta agua sin cloro se necesita tener a la mano. Los tamaños de los tanques a menudo se calculan en términos de galones—trabaje con su estudiante para convertir el volumen de agua en galones.

- Encuentren la cantidad de grava que se necesita multiplicando el alto de la grava en el tanque por el área de la base del acuario. Asegúrese de enjuagar su grava y que no contenga sustancias químicas antes de colocarlas en el acuario.

- Usen el volumen de agua en el tanque y al área superficial del tanque para averiguar cuántas plantas y animales pueden caber en su acuario. Quienes tienen por pasatiempo criar peces y las tiendas de acuarios, pueden ayudarlos a averiguar cómo implementar su acuario.

Necesitará cambiar el agua de su acuario de forma regular (alrededor de un tercio del volumen cada semana). ¿Cuánta agua sin cloro necesitará tener a mano? Según los animales y plantas que escoja, también querrá usar un sistema de filtro y un calentador de agua.

¡Muy pronto estarán disfrutando a sus nuevas mascotas!

How can you determine the amount of cardboard used to make a cereal box? List at least two different methods.

Evaluate the expression.

1. $2(2)(5) + 2(2)(3) + 2(5)(3)$

2. $2(1)(4) + 2(1)(2) + 2(4)(2)$

3. $2(6)(3) + 2(6)(1) + 2(3)(1)$

4. $2(3)(7) + 2(3)(5) + 2(7)(5)$

5. $2(2)(2) + 2(2)(4) + 2(2)(4)$

6. $2(4)(8) + 2(4)(10) + 2(8)(10)$

Start Thinking!
For use before Lesson 9.1

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

What kind of units are used to measure surface area?

Lesson 9.1

Warm Up
For use before Lesson 9.1

Use one-inch cubes to form a rectangular prism that has the given dimensions. Then find the surface area of the prism.

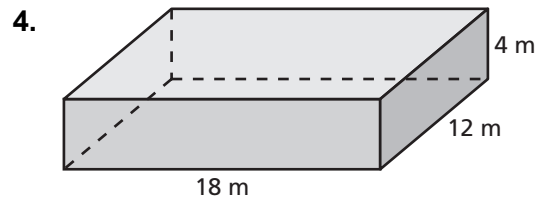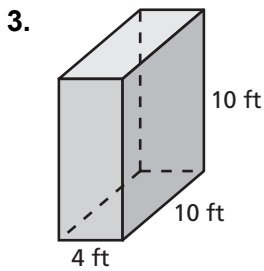**1.** $2 \times 2 \times 3$

2. $1 \times 1 \times 5$

3. $3 \times 2 \times 4$

4. $1 \times 3 \times 5$

Name_____ Date _____

9.1 Practice A

Find the surface area of the prism.

1.

10 cm

2 cm

8 cm

2.

10 in.

6 in.

8 in.

10 in.

16 in.

3.

10 ft

10 ft

4 ft

4.

4 m

12 m

18 m

5.

24 in.

40 in.

10 in.

26 in.

6.

12 cm

16 cm

4 cm

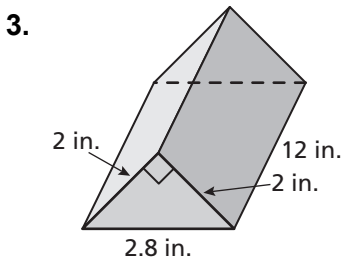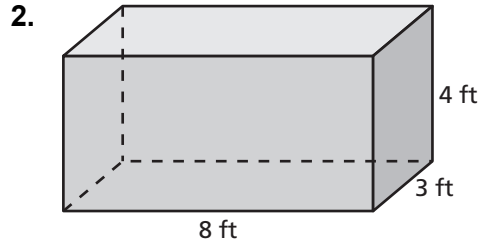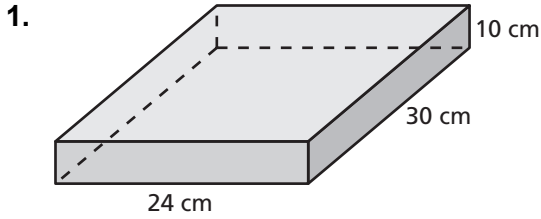20 cm
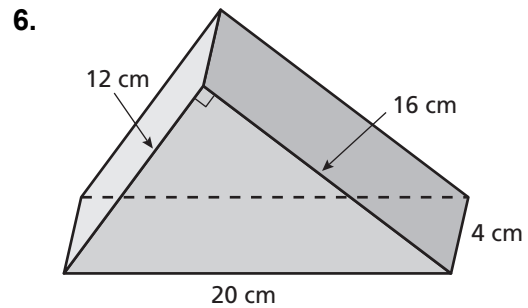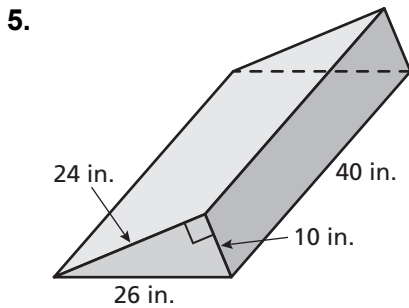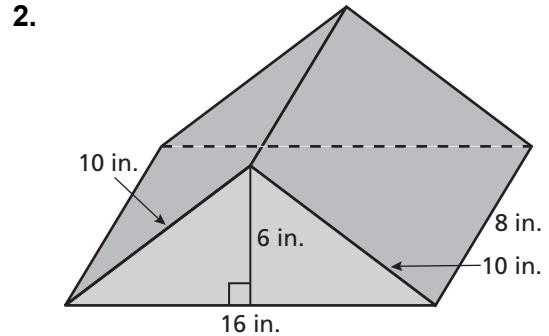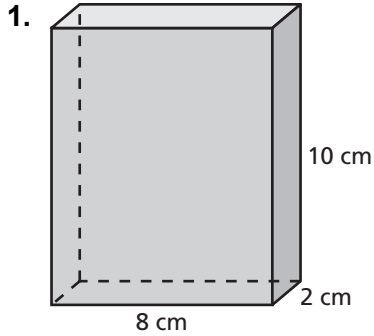
7. The inside of a baking pan is to be lined with tinfoil. The pan is 12 inches long, 9 inches wide, and 1.5 inches tall. How many square inches of tinfoil are needed?

8. Draw and label a rectangular prism that has a surface area of 96 square meters.

Name _____ Date _____

Find the surface area of the prism.

1.

10 cm

30 cm

24 cm

2.

4 ft

3 ft

8 ft

3.

2 in.

12 in.

2 in.

2.8 in.

4.

14 m

28 m

14 m

10 m

20 m

5.

18 cm

10 cm

10 cm

4 cm

34 cm

6 cm

6.

6 ft

16 ft

6 ft
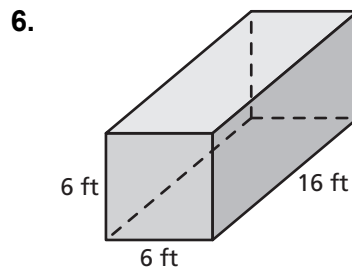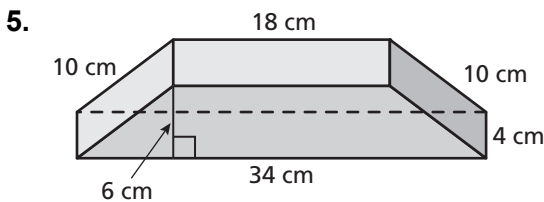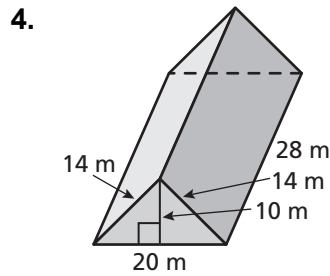
7. A graphing calculator is in the approximate shape of a rectangular prism.

    a. Estimate the total surface area of the calculator.

    b. The window of the calculator is 6.5 centimeters long and 4.5 centimeters wide. Estimate the surface of the graphing calculator without the window.

9 cm

19 cm

2.5 cm

GRAPHING XT

GXT-2000
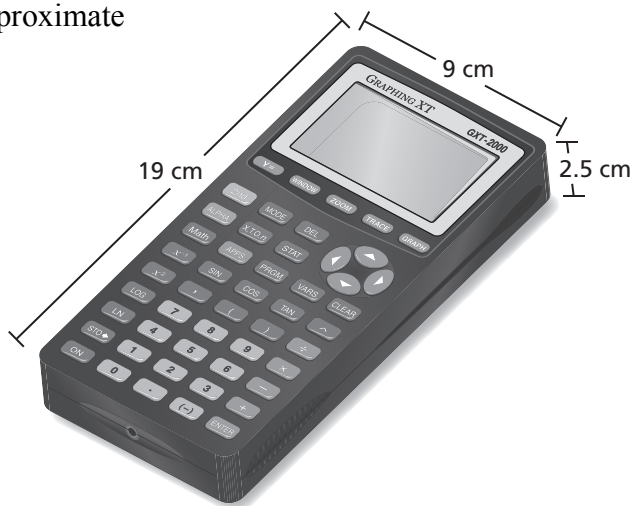
8. The least amount of wrapping paper needed to wrap a cube-shaped gift is 150 square inches. How long is one side of the gift?

Name_____ Date _____

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?

2. 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.

   18.1 in.

   9.3 in.

   13 in.

   1 in.

   7.8 in.

   4.8 in.

   5.3 in.

   5.1 in.

   5.9 in.

   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.
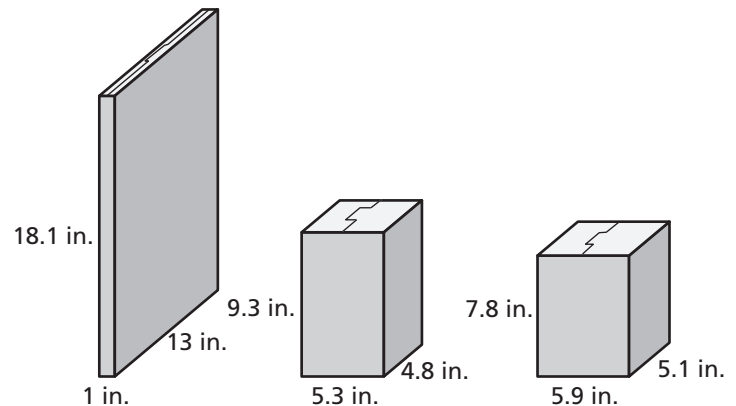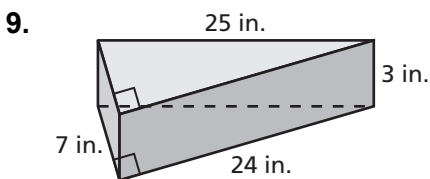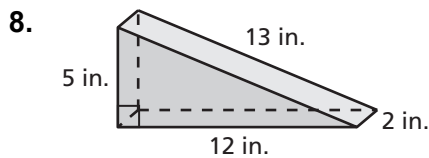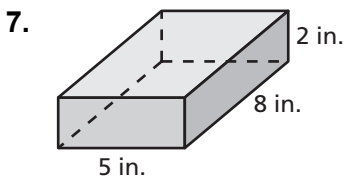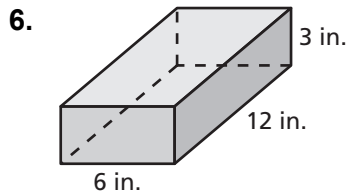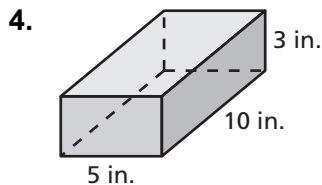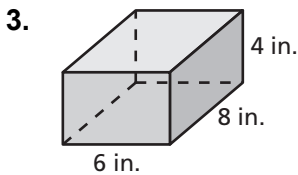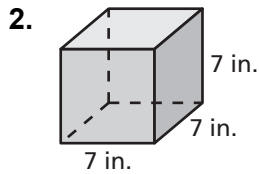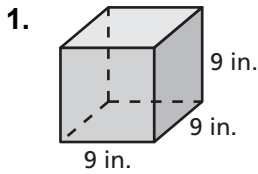
3. Look for a pattern in Exercises 1 and 2. Predict what kind of rectangular prism has the least surface area.

9.1 Puzzle Time

What Did The Little Tire Want To Be When He Grew Up?

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

Find the surface area of the prism.

1.

9 in.
9 in.
9 in.

2.

7 in.
7 in.
7 in.

3.

4 in.
8 in.
6 in.

4.

3 in.
10 in.
5 in.

5.

4 in.
7 in.
7 in.

6.

3 in.
12 in.
6 in.

7.

2 in.
8 in.
5 in.

8.

13 in.
5 in.
2 in.
12 in.

9.

25 in.
3 in.
7 in.
24 in.
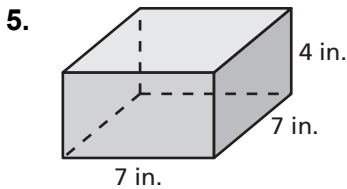
Answers
H. 190 in.^{2}
L. 208 in.^{2}
I. 210 in.^{2}
B. 120 in.^{2}
W. 132 in.^{2}
G. 294 in.^{2}
A. 486 in.^{2}
E. 336 in.^{2}
E. 252 in.^{2}

1		8	5	2		7	4	9	6	3

Are the sides of a pyramid always triangles?
Explain.

Is the base of a pyramid always a triangle?
Explain.

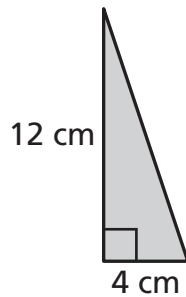**Activity 9.2**

Warm Up
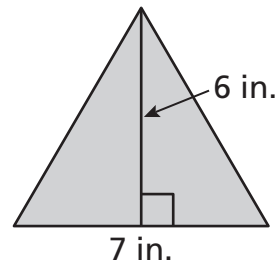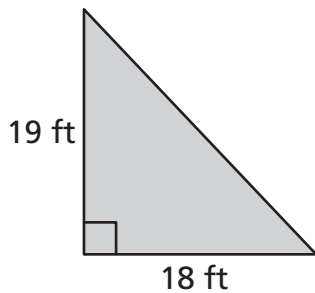For use before Activity 9.2

Find the area.

1.

12 cm

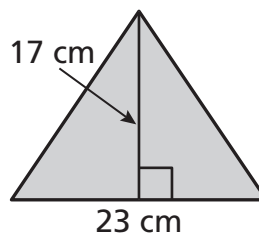4 cm

2.

6 in.

7 in.

3.

19 ft

18 ft

4.

17 cm

23 cm

Start Thinking!
For use before Lesson 9.2

Your neighbor needs to put a new roof on his gazebo. The roof is an octagonal pyramid. Why would knowing the surface area of the roof be useful information?
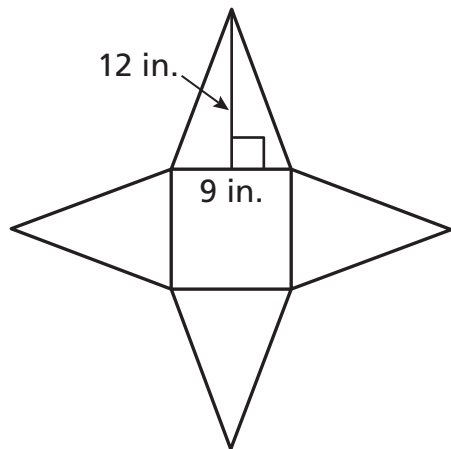
Warm Up
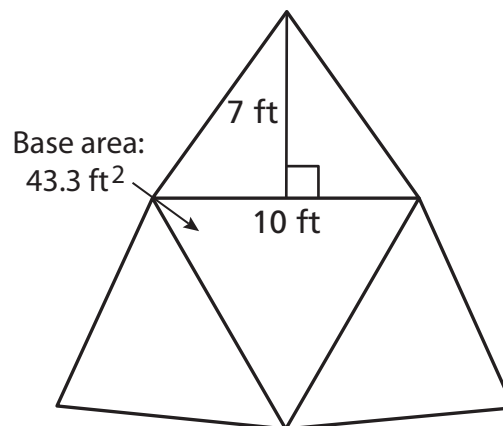**For use before Lesson 9.2**

Use the net to find the surface area of the regular pyramid.

1.

12 in.

9 in.

2.
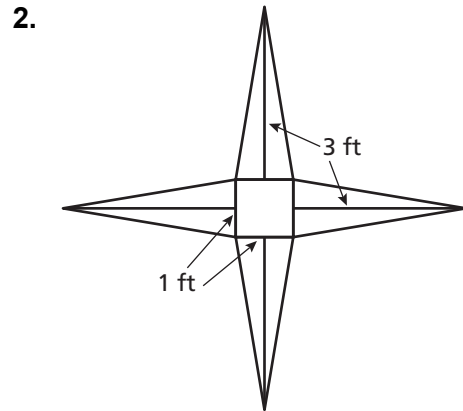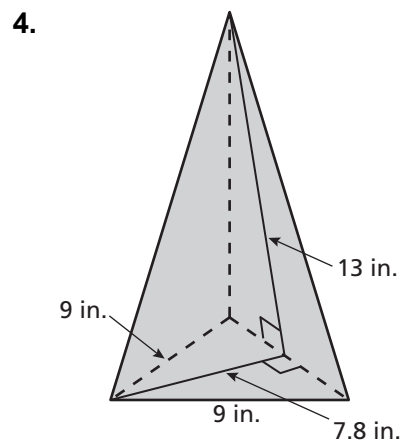
7 ft

Base area:
43.3 ft^2

10 ft

Name_____ Date _____

9.2 Practice A

Use the net to find the surface area of the regular pyramid.

1.

4 cm

3.5 cm

4 cm

5 cm

2.

3 ft

1 ft

Find the surface area of the regular pyramid.

3.

4 m

3 m

3 m

4.

13 in.

9 in.

9 in.

7.8 in.
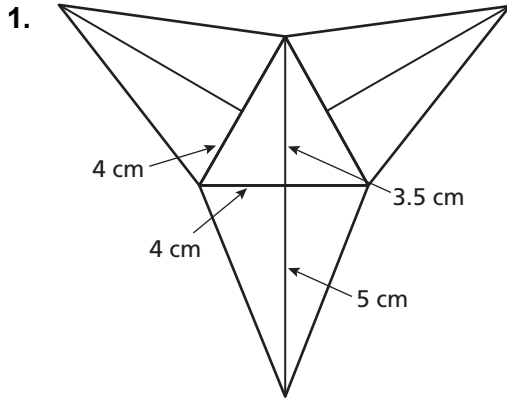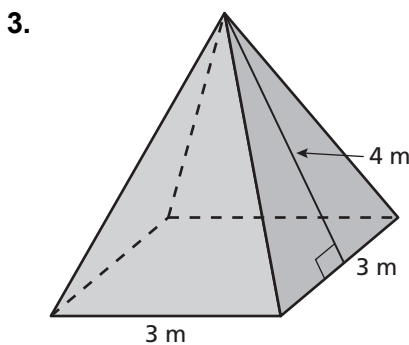
5. Your friend is purchasing an umbrella with a slant height of 4 feet. There are a variety of such umbrellas to choose from.

   a. A red umbrella is shaped like a regular pentagonal pyramid with a side length of 3 feet. Find the lateral surface area of the red umbrella.

   b. A yellow umbrella is shaped like a regular hexagonal pyramid with a side length of 2.5 feet. Find the lateral surface area of the yellow umbrella.

   c. A blue umbrella is shaped like a regular octagonal pyramid with a side length of 1.9 feet. Find the lateral surface area of the blue umbrella.

   d. Based on lateral surface areas, would you suggest that your friend pick the umbrella that is her favorite color? Explain.

Name _____ Date _____

Find the surface area of the regular pyramid.

1.

4.3 cm

4.3 cm   6 cm

2.

21 ft

14 ft

14 ft

12.1 ft
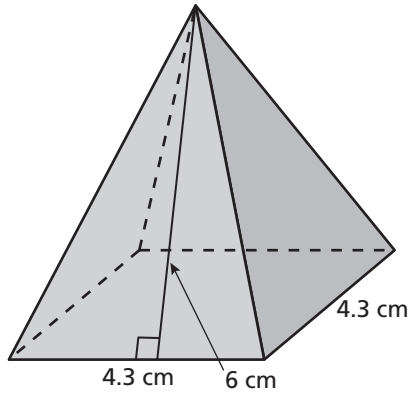
3. Researchers have determined that a hip roof offers the most protection to a house during a hurricane.
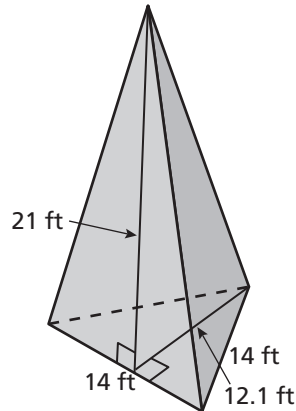
   a. The house has a square base with a side length of 50 feet. The house has a variation of a hip roof in the shape of a regular pyramid with a square base. The roof extends 1 foot beyond the walls of the house on all sides. What is the length of each side of the base of the roof?

   b. The slant height of the roof is 35 feet. Find the sum of the areas of the lateral faces of the pyramid.

   c. A metal roof covering offers the most protection to a house during a hurricane. The cost of installing metal roof covering is $350 for every 100 square feet of roof. What is the cost of installing a metal roof covering on the house?

4. The surface area of a regular triangular pyramid is 197.1 square meters. The slant height is 12 meters. The area of the base is 35.1 square meters. The base length is 9 meters. What is the height of the triangular base?

5. The surface area of a regular pentagonal pyramid is 125 square yards. The base length is 5 yards. The area of the base is 37.5 square yards. What is the slant height of the pyramid?

Name_____ Date _____

9.2 Enrichment and Extension

Scaling Down the Pyramids

Imagine that you are planning to make scale models of the square pyramids described below. (See Activity 1 in Section 9.2 in your textbook for pictures of the pyramids.) You will be making them out of plywood. Plywood is sold in sheets that are 4 feet by 8 feet.

Pyramid	Actual side length (m)	Actual slant height (m)
Cheops Pyramid in Egypt	230	186
Muttart Conservatory in Edmonton	26	27
Louvre Pyramid in Paris	35	28
Pyramid of Caius Cestius in Rome	22	29

1. You have decided that your scale should be 1 m = 0.5 cm. Why should you use this as your scale instead of 1 m = 1 cm?

2. Find the side length and slant height of the models, and complete the table.

Pyramid	Model side length (cm)	Model slant height (cm)
Cheops Pyramid in Egypt		
Muttart Conservatory in Edmonton		
Louvre Pyramid in Paris		
Pyramid of Caius Cestius in Rome		

3. What is the least amount of plywood (in square centimeters) you would need to make all the models? How many sheets of plywood is this?

4. When purchasing the plywood, the salesman offers half sheets of plywood that are 4 feet by 4 feet.

   a. Using your answer to Exercise 3, can you replace one of the full sheets of plywood with a half sheet of plywood? Explain.

   b. Check to see if your answer to part (a) is correct by showing how the models can be cut from the plywood. Explain.

9.2 Puzzle Time

Where Do You Find Baby Soldiers?

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

Find the surface area of the regular pyramid.

1. Square base: side length = 5 cm; slant height = 12 cm

2. Square base: side length = 8 cm; slant height = 15 cm

3. Square base: side length = 9 cm; slant height = 14 cm

4. Triangular base: side length = 6 cm;
   slant height = 8 cm; height of base triangle = 5.2 cm

5. Triangular base: side length = 14 cm;
   slant height = 18 cm; height of base triangle = 12.1 cm

6. Triangular base: side length = 12 cm; slant height = 15 cm;
   height of base triangle = 10.4 cm

Find the surface area of the *lateral faces* of the regular pyramid.

7. Pentagonal base: side length = 7 cm; slant height = 12 cm

8. Hexagonal base: side length = 10 cm; slant height = 13 cm

9. Octagonal base: side length = 12 cm; slant height = 16 cm

10. The top of a play canopy tent forms a pyramid with a square base. The
    sides of the base are 8.5 centimeters. The slant height is 5.4 centimeters.
    How much canvas is needed to make the canopy?

11. The base of a glass paperweight is a regular hexagon with a side length of
    6 centimeters. The area of the base is 93.6 square centimeters. The slant
    height is 12 centimeters. What is the surface area of the paperweight?

Answers

N. 332.4 cm^2

Y. 309.6 cm^2

A. 304 cm^2

E. 87.6 cm^2

R. 333 cm^2

T. 768 cm^2

I. 210 cm^2

T. 462.7 cm^2

N. 390 cm^2

F. 91.8 cm^2

H. 145 cm^2

5	1	4		7	8	10	2	6	9	3	11

Give a real-life example of when it would be useful to know the surface area of a cylinder.

Find the area. Use 3.14 for π.

1.

3 in.

2.

7 ft

3.

10 cm

4.

8 cm
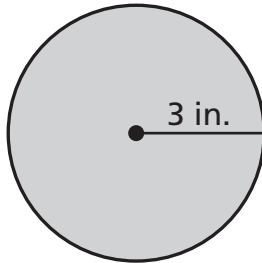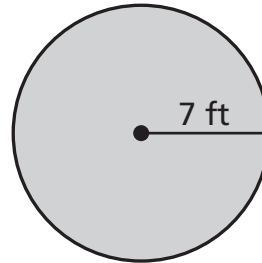
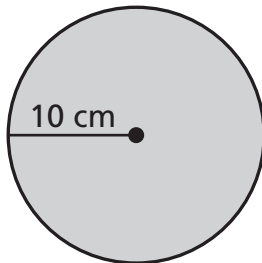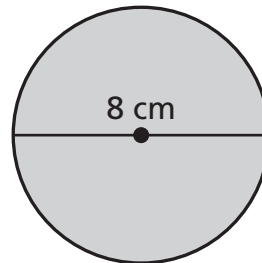## Start Thinking!
For use before Lesson 9.3

Explain which cylinder has a greater surface area:

Radius: 4 cm; Height: 10 cm

Radius: 10 cm; Height: 4 cm
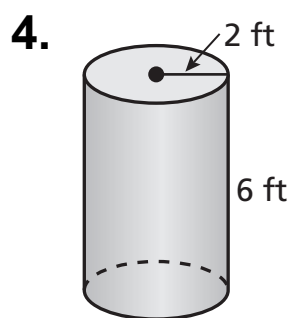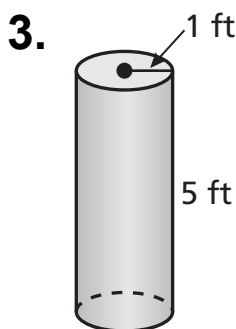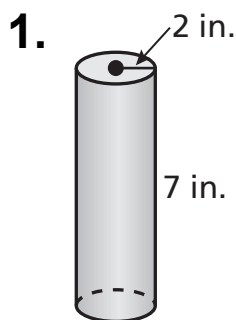
Lesson
9.3

Warm Up
For use before Lesson 9.3

Make a net for the cylinder. Then find the surface area of the cylinder. Round your answer to the nearest tenth.

1. 2 in.

7 in.

2. 3 in.

4 in.

3. 1 ft

5 ft

4. 2 ft

6 ft
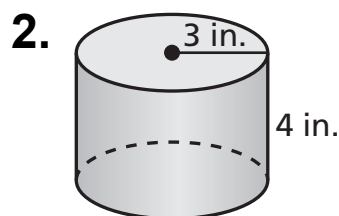
9.3 Practice A

Make a net for the cylinder. Then find the surface area of the cylinder. Round your answer to the nearest tenth.

1.

4 in.

2 in.

2.

5 m

1 m

Find the surface area of the cylinder. Round your answer to the nearest tenth.

3.

4 ft

12 ft

4.

8 mm

3 mm

Find the lateral surface area of the cylinder. Round your answer to the nearest tenth.

5.

3 cm

3 cm

6.

9 yd

1 yd
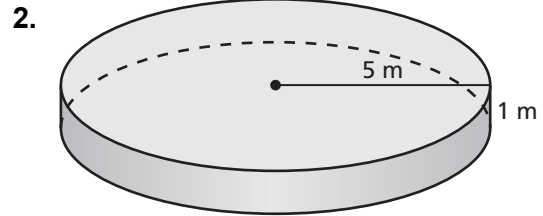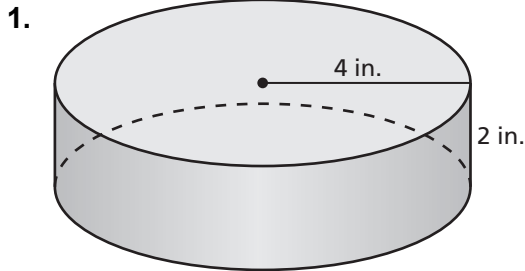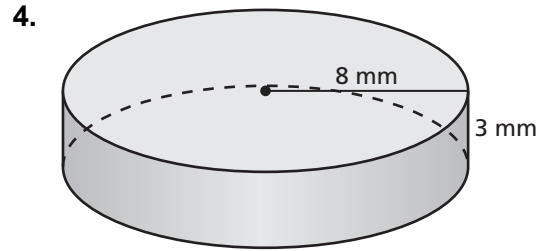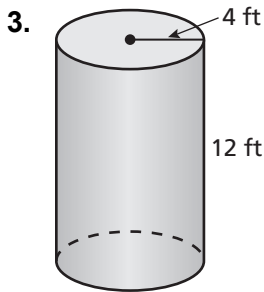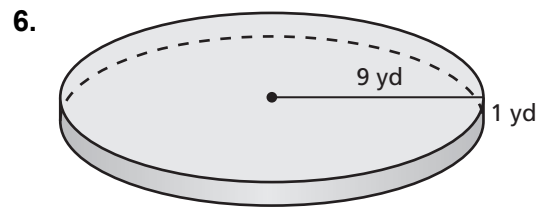
7. A deep dish pizza has a radius of 6 inches and a height of 1 inch. Find the surface area of the pizza. Round your answer to the nearest tenth.

Name _____ Date _____

Find the surface area of the cylinder. Round your answer to the nearest tenth.

1.

12 ft

5 ft

2.

1 cm

9 cm

Find the lateral surface area of the cylinder. Round your answer to the nearest tenth.

3.

13 m

10 m

4.

8 in.

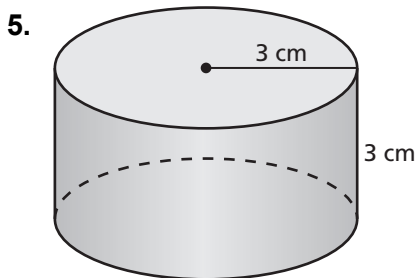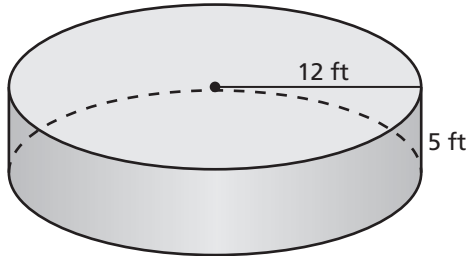11 in.
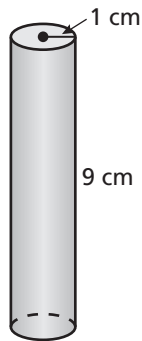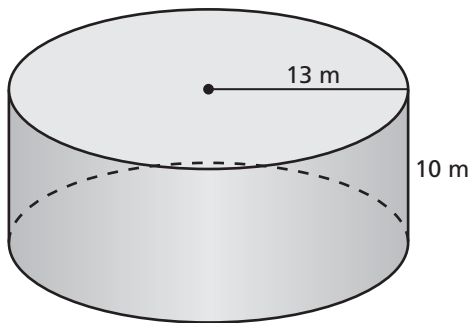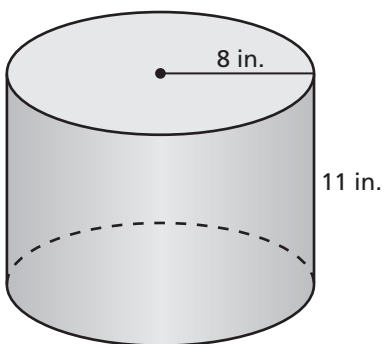
5. A quarter is worth $0.25 and a half dollar is worth $0.50.

   a. A quarter has a diameter of $\frac{15}{16}$ inch and a height of $\frac{1}{16}$ inch. Find the surface area of a quarter. Round your answer to the nearest hundredth.

   b. A half dollar has a diameter of $\frac{9}{8}$ inches and a height of $\frac{3}{32}$ inch. Find the surface area of a half dollar. Round your answer to the nearest hundredth.

   c. Show that the value of the coin is not proportional to the surface area of the coin.

   d. If the values of the coins were proportional to the surface areas of the coins, what would be the surface area of the half dollar? Round your answer to the nearest hundredth.

9.3 **Enrichment and Extension**

The Icing on the Cake

Answer the following questions. As you calculate the surface area that icing covers, keep in mind that the bottom of the cake does not get any icing.

1. A cylindrical cake is made in a pan that has a diameter of 9 inches and a height of $1\frac{1}{2}$ inches.

    a. What is the total surface area of the cake?

    b. The cake is cut into 10 equal-sized wedges. What is the total surface area of the cake now?

    c. After the cake is cut, what percent of the cake's surface is covered with icing?

    d. Cake does not stay as moist after it has been cut into pieces. Use surface area to explain this.

2. José has decided to make a heart-shaped cake using a square pan that is 9 inches by 9 inches and a circular pan with a diameter of 9 inches. Both pans are $1\frac{1}{2}$ inches tall. The diagram below shows the top view of the cake.
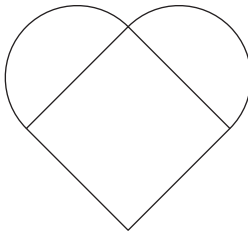
    a. José knows from experience that one 8-ounce container of icing will cover a cake made from his square pan exactly the way he likes it. If he covers his heart-shaped cake the same way, how many ounces of icing will he use?

    b. How many 8-ounce containers of icing will he have to buy? How much icing will be left over?

9.3 **Puzzle Time**

Did You Hear About...

A	B	C	D	E	F
G	H	I	J	K	L
M	N	O	P	Q	R

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

Answer
565.2 m² **WEEK**
276.3 m² **AND**
753.6 ft² **HIS**
424.3 in.² **CATCH**
401.9 m² **BOUGHT**
325.2 ft² **DAY**
439.6 cm² **AWAY**
301.4 m² **OLD**
282.6 cm² **BOOMERANG**
533.8 in.² **THROW**
100.5 ft² **MAN**

Find the combined area of *both bases* of the cylinder. Use 3.14 for π. Round to the nearest tenth.

A. $r = 2$ in.　　　　**B.** $r = 4$ ft

C. $r = 5$ cm　　　　**D.** $r = 8$ m

Find the area of the *lateral surface* of the cylinder. Use 3.14 for π. Round to the nearest tenth.

E. $r = 3$ ft; $h = 6$ ft　　**F.** $r = 8$ in.; $h = 7$ in.

G. $r = 9$ cm; $h = 5$ cm　　**H.** $r = 4$ m; $h = 11$ m

Find the surface area of the cylinder. Use 3.14 for π. Round to the nearest tenth.

I. $r = 1$ in.; $h = 7$ in.　　**J.** $r = 5$ cm; $h = 3$ cm

K. $r = 6$ m; $h = 9$ m　　**L.** $r = 2$ ft; $h = 8$ ft

M. $r = 4$ m; $h = 4$ m　　**N.** $r = 5$ in.; $h = 12$ in.

O. $r = 10$ ft; $h = 2$ ft　　**P.** $r = 3$ m; $h = 13$ m

Q. A cylindrical cookie jar has a height of 9 inches. The radius of its base is 4 inches. What is its surface area?

R. A cylindrical coffee can has a height of 14 centimeters. The radius of its base is 5 centimeters. What is the area of its label?

Answer
113.0 ft² **A**
25.1 in.² **THE**
35.6 m² **STORE**
201.0 m² **TO**
50.2 in.² **SPENT**
326.6 in.² **ONE**
187.4 cm² **BUY**
125.6 ft² **TRYING**
157 cm² **WHO**
251.2 cm² **A**
351.7 in.² **NEW**

Activity 9.4 **Start Thinking!**
For use before Activity 9.4

Do two-dimensional figures have volume?
Explain.

Do three-dimensional figures have volume?
Explain.

Activity 9.4 **Warm Up**
For use before Activity 9.4

Multiply.

1. $7 \times 5 \times 8$ **2.** $12 \times 7 \times 8$

3. $(13)(10)(7)$ **4.** $11 \cdot 15 \cdot 3$

5. $(14)(20)(4)$ **6.** $12 \cdot 16 \cdot 21$

Start Thinking!

For use before Lesson 9.4

You are buying decorative sand for art projects. Explain how volume would be helpful in figuring out which size box to use to store the decorative sand.
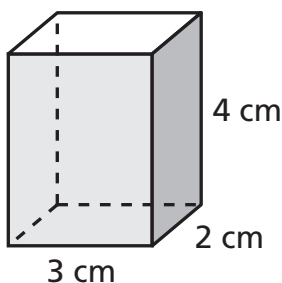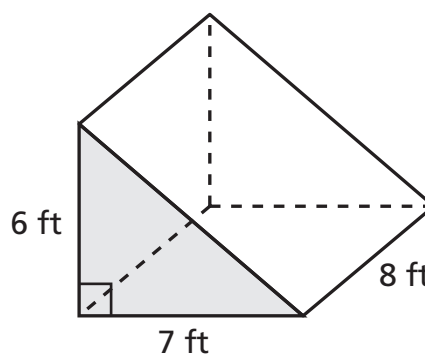
Warm Up

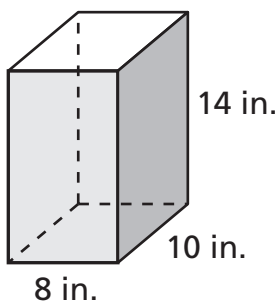**For use before Lesson 9.4**

Find the volume of the prism.
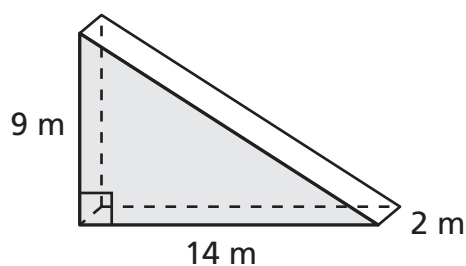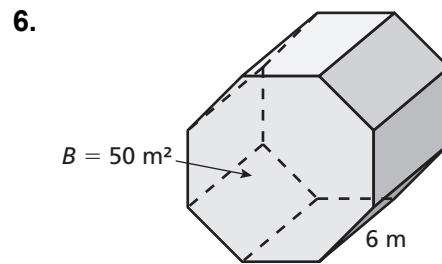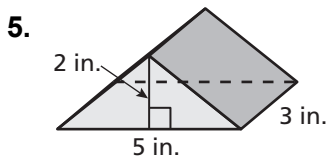
1.

4 cm

2 cm

3 cm

2.

6 ft
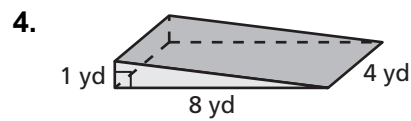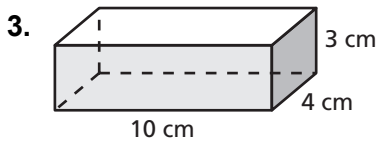
8 ft

7 ft

3.

14 in.

10 in.

8 in.

4.

9 m

14 m

2 m

9.4 Practice A

Find the volume of the prism.

1.

6 in.

2 in.

3 in.

2.

5 m

9 m

6 m

3.

3 cm

4 cm

10 cm

4.

1 yd

4 yd

8 yd

5.

2 in.

3 in.

5 in.

6.

$B = 50\ m^2$

6 m
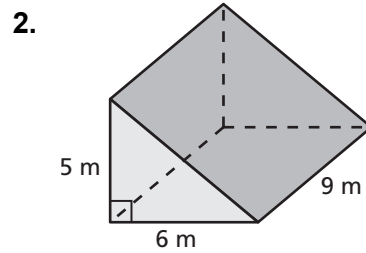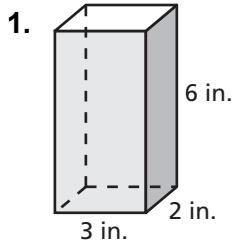
7. A cell phone is in the shape of a rectangular prism, with a length of 4 inches, a width of 2 inches, and a height of 1 inch. What is the volume of the cell phone?

8. A recycle bin is in the shape of a trapezoidal prism. The area of the base is 220 square inches and the height is 24 inches. What is the volume of the recycle bin?

9. A water jug is in the shape of a prism. The area of the base is 100 square inches and the height is 20 inches. How many gallons of water will the water jug hold? $\left(1\ gal\ =\ 231\ in.^3\right)$ Round your answer to the nearest tenth.

Name _____ Date _____

Find the volume of the prism.

1.

10 cm
20 cm
60 cm

2.

10 m
15 m
25 m

3.

3.5 in.
7 in.
5.2 in.

4.

1 cm
2.5 cm
9 cm

5.

1.2 yd
6 yd
3 yd

6.

$B = 86$ m²
15 m
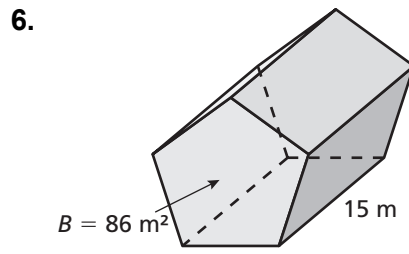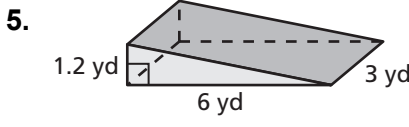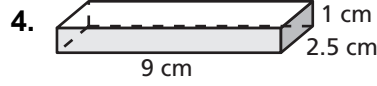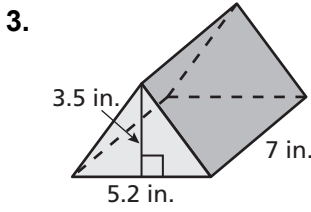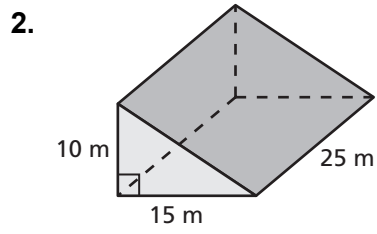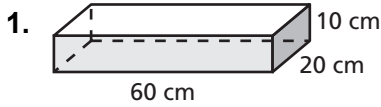
7. A mailbox is in the shape of a prism. The area of the base is 52 square inches and the height is 18 inches. What is the volume of the mailbox?

8. A chicken broth container is in the shape of a rectangular prism, with a length of 9.5 centimeters, a width of 6 centimeters, and a height of 16.5 centimeters. The container is 90% full. How many liters of chicken broth are in the container? $\left(1 \text{ L } = 1000 \text{ cm}^3\right)$ Round your answer to the nearest hundredth.

9. How many cubic feet are in a cubic yard? Use a sketch to explain your reasoning.

9.4   Enrichment and Extension

Brain Buster Boxes

As you work, keep in mind that prisms with the same dimensions in a different order do not count as different prisms. (For example, a rectangular prism that is 5 inches long, 10 inches wide, and 10 inches tall is the same as a rectangular prism that is 10 inches long, 10 inches wide, and 5 inches tall. The prism has just been rotated.)

1. Make a list of all the different rectangular prisms you can make using only side lengths of 5 inches, 10 inches, and 15 inches.

   a. Find the volume and surface area of each of your prisms.

   b. Copy and complete the table by putting the volumes in order from least to greatest.

Length	Width	Height	Volume	Surface Area

2. Make a list of all the different rectangular prisms you can make using only side lengths of 5 inches, 8 inches, 15 inches, and 50 inches.

   a. Find the volume and surface area of each of your prisms.

   b. Use a table similar to Exercise 1 part (b) to put the volumes in order from least to greatest.

3. Look at both tables. As the volume increases, describe what happens to the surface area. Describe any patterns that you see.

4. How would you change the dimensions of a rectangular prism box so that it holds more while using less cardboard to make?

9.4 Puzzle Time

What Game Do Bakers Like To Play?

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

Find the volume of the prism.

1. a rectangular prism measuring 9 inches by 4 inches by 15 inches

2. a rectangular prism that measures 7 centimeters by 5 centimeters by 12 centimeters

3. a rectangular prism that measures 6 feet by 8 feet by 7 feet

4. a triangular prism with bases that have a base of 8 inches and a height of 12 inches; The height of the prism is 5 inches.

5. a triangular prism with bases that have a base of 7 feet and a height of 4 feet; The height of the prism is 9 feet.

6. a triangular prism with bases that have a base of 11 centimeters and a height of 8 centimeters; The height of the prism is 4 centimeters.

7. a pentagonal prism with a base area of 92 square inches; The height of the prism is 6 inches.

8. a hexagonal prism with a base area of 81 square centimeters; The height of the prism is 9 centimeters.

9. A baking dish shaped like a rectangular prism measures 9 inches by 12 inches by 2 inches. What is the volume of the dish?

10. A salt shaker is shaped like a pentagonal prism. Its base area is 18 square centimeters. The height of the prism is 9 centimeters. What is the volume of the salt shaker?

11. A flower garden box is shaped like an octagonal prism. The base area is 48 square feet. The height of the prism is 2 feet. What is the volume of the flower garden box?

Answers
G. 96 ft^3
C. 162 cm^3
A. 540 in.^3
H. 420 cm^3
T. 552 in.^3
U. 126 ft^3
D. 729 cm^3
I. 176 cm^3
O. 336 ft^3
C. 216 in.^3
T. 240 in.^3

4	6	10		7	1	9		8	3	5	11	2

Start Thinking!
For use before Activity 9.5

Explain the difference between the slant height of a pyramid and the height of a pyramid.

Which do you use for volume? Which do you use for surface area?

Activity
9.5

Warm Up
For use before Activity 9.5

Multiply.

1. $\dfrac{2}{3} \times 15$

2. $\dfrac{3}{4} \times 8$

3. $\dfrac{7}{10} \times 6$

4. $\dfrac{1}{3} \times 18$

5. $\dfrac{5}{9} \times 30$

6. $\dfrac{4}{13} \times 72$

Start Thinking!
For use before Lesson 9.5

Give a real-life example of how knowing the volume of a pyramid would be beneficial.

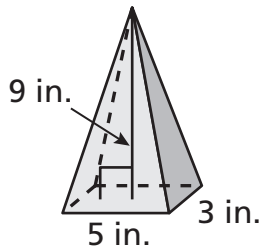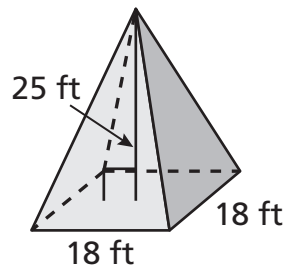**Lesson 9.5**

Warm Up
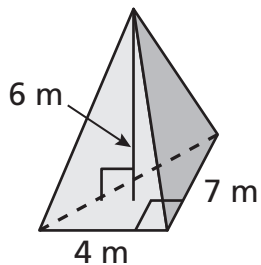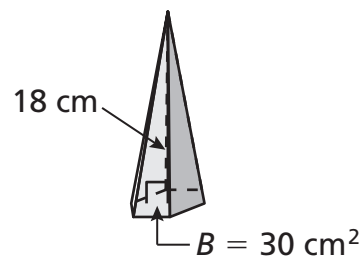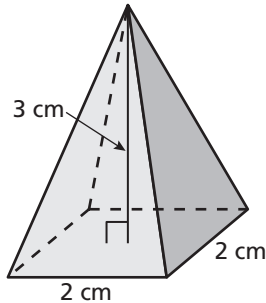For use before Lesson 9.5

Find the volume of the pyramid.

1.

9 in.

3 in.

5 in.

2.

25 ft

18 ft

18 ft

3.

6 m

7 m

4 m

4.

18 cm

$B = 30 \text{ cm}^2$

9.5   Practice A

Find the volume of the pyramid.

1.

3 cm

2 cm

2 cm

2.

8 in.

7 in.

9 in.

3.

5 m

$B = 30$ m²

4.

9 ft

5 ft

8 ft
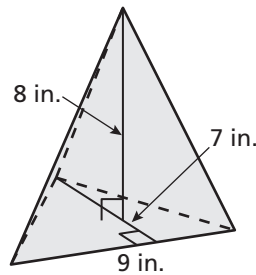
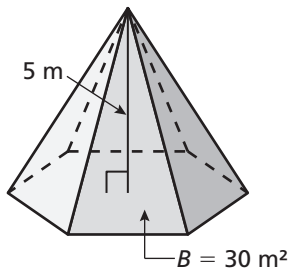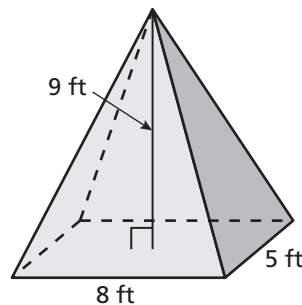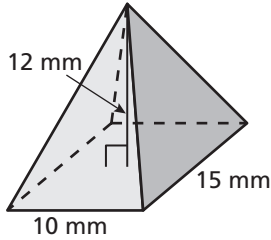**5.** A tent is in the shape of a pyramid. The base is a rectangle with a length of 12 feet and a width of 10 feet. The height of the tent is 8 feet. Find the volume of the tent.

6. A sign made of solid wood is in the shape of a pyramid. The base is a triangle with a base of 6 feet and a height of 4 feet. The height of the sign is 7 feet. The wood costs $3 per cubic foot. What is the cost of the sign?

7. Two pyramids with square bases have the same volume. One pyramid has a height of 6 centimeters and the area of the base is 36 square centimeters.

   a. What is the volume of the pyramids?

   b. The base of the other pyramid has a side length of 3 centimeters. What is the height of this pyramid?

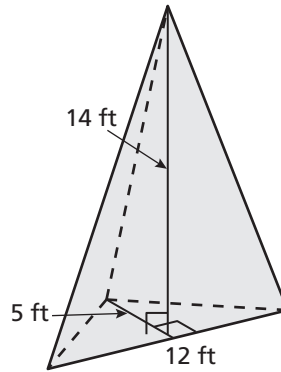**8.** How does the volume of a pyramid change when the height is halved?

Name _____ Date _____

Find the volume of the pyramid.

1.

12 mm

15 mm

10 mm

2.

14 ft
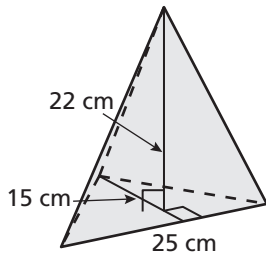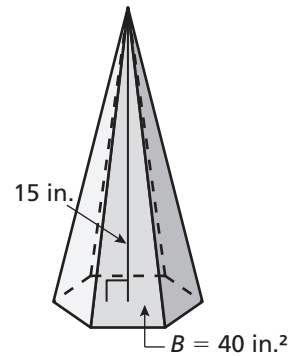
5 ft

12 ft

3.

22 cm

15 cm

25 cm

4.

15 in.

B = 40 in.²

5. A pyramid has a rectangular base with length of 15 feet and a width of 8 feet. The height of the pyramid is 10 feet.

   a. Find the volume of the pyramid.

   b. When the pyramid was being built, the original base was dropped and it split in two pieces. Each piece was a triangle with a base of 15 feet and a height of 8 feet. Pyramids were made with these two bases, each with a height of 10 feet. Find the combined volume of the two pyramids.

   c. Is the combined volume *greater than*, *less than*, or the *same as* the volume of the pyramid?

9.5 Enrichment and Extension

Measuring Up with Sand

Children at the beach often spend a lot of time pouring sand and water from one bucket to another bucket.

1. You have a bucket that is a cube with a side length of 4 inches that you fill with sand. You pour its contents into a bucket that is a square pyramid with a base length of 4 inches and a height of 10 inches. Will the sand spill over? If so, how much sand will spill out? If not, how high will the sand be in the pyramid bucket?

2. Your friend has a bucket that is a square pyramid with a base length of 6 inches and a height of 9 inches that is full of sand. Your friend pours the sand into a cylindrical bucket with a diameter of 6 inches and a height of 9 inches. Will the sand spill over? If so, how much sand will spill out? If not, how high will the sand be in the cylindrical bucket?

3. Another friend has two buckets, one that is a triangular pyramid and one that is a triangular prism. The bases of both buckets are triangles with a base of 3 inches and a height of 4 inches. The pyramid is 6 inches tall. When you fill the pyramid with sand and pour it into the prism, it fills the prism exactly. What is the height of the prism?

4. You borrow a cylindrical bucket. You fill the cube bucket from Exercise 1 with water and pour the entire contents into this cylindrical bucket. The water is 7 inches high. Does this cylindrical bucket have a larger or smaller diameter than the cylindrical bucket from Exercise 2? Explain your reasoning.

5. You enter a sand castle building contest. You are given a bucket that is a square prism with base length of 6 inches and height of 10 inches that is full of red sand. According to the rules for the competition, you can use only this sand and nothing more, but you do not have to use all the sand. How would you design your sand castle? Draw a picture and give the names, dimensions, and volumes of the shapes you would use in your castle. Assume that you can form whatever shapes and sizes you choose.

9.5 Puzzle Time

What Do You Get If You Add Two Bananas To Three Apples?

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

Find the volume of the pyramid with area of base *B* and height *h*.

1. $B = 16$ in.^{2}; $h = 9$ in.

    G. 38 in.^{3} **H.** 46 in.^{3} **I.** 48 in.^{3}

2. $B = 168$ cm^2; $h = 13$ cm

    L. 728 cm^3 **M.** 752 cm^3 **N.** 768 cm^3

3. $B = 54$ ft^2; $h = 7$ ft

    Q. 96 ft^3 **R.** 126 ft^3 **S.** 148 ft^3

4. $B = 67$ m^2; $h = 18$ m

    A. 402 m^3 **B.** 424 m^3 **C.** 468 m^3

5. $B = 55$ cm^2; $h = 6$ cm

    C. 90 cm^3 **D.** 110 cm^3 **E.** 130 cm^3

6. $B = 63$ mm^2; $h = 13$ mm

    R. 203 mm^3 **S.** 243 mm^3 **T.** 273 mm^3

7. $B = 78$ ft^2; $h = 11$ ft

    F. 286 ft^3 **G.** 206 ft^3 **H.** 196 ft^3

8. $B = 311$ yd^2; $h = 15$ yd

    A. 1555 yd^3 **B.** 1015 yd^3 **C.** 1225 yd^3

9. A grocery store has a display of tuna cans stacked to form a rectangular pyramid that is 5 feet tall. The base is 9 feet by 7 feet. What is the volume of the display?

    R. 95 ft^3 **S.** 105 ft^3 **T.** 135 ft^3

10. Building a campfire, you start by stacking kindling wood to form a pentagonal pyramid that is 27 centimeters tall. The base area is 965 square centimeters. What is the volume of the campfire pyramid?

    U. 8685 cm^3 **V.** 8852 cm^3 **W.** 9285 cm^3

7	3	10	1	6		9	4	2	8	5

Start Thinking!

For use before Extension 9.5

List examples of solids you see around the classroom.

Extension 9.5

Warm Up

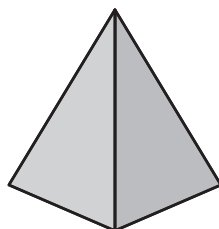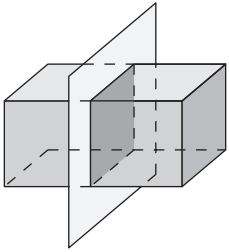For use before Extension 9.5

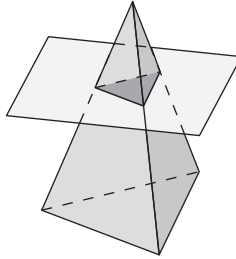## Identify the solid.

1.
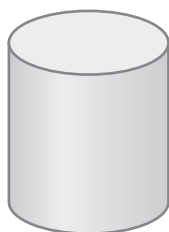
2.

3.

4.

Extension
9.5 **Practice**

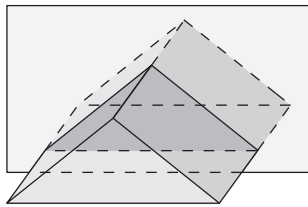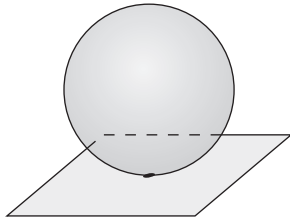**Describe the intersection of the plane and the solid.**

1.

2.

3.
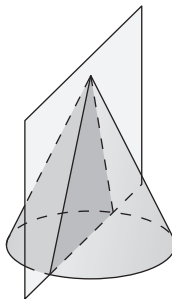
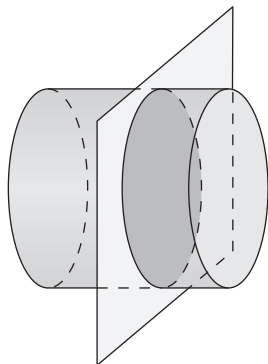**4.**
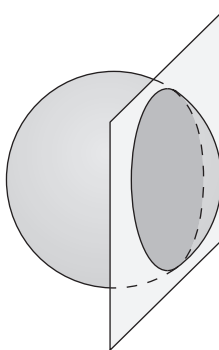
5.

6.

7.

8.

Name_____ Date _____
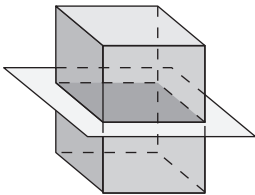
Chapter 9 **Technology Connection**
For use after Section 9.1

Changing the side length of a cube

You can use a spreadsheet to find out how changing the side length of a cube affects the surface area of the cube.

EXAMPLE What happens to the surface area of a cube when its side length is doubled?

SOLUTION

Step 1 Create a spreadsheet. Put an original side length in cell A2 and the amount to multiply that length by in cell B2.

	A	B	C	D	E	F
1	Original side length	Multiplier	New side length	Original surface area	New surface area	Ratio of new to original surface area
2	5	2	=A2*B2	=6*A2^2	6*C2^2	=E2/D2
3						

Step 2 Enter a formula for the new side length in cell C2.

Step 3 Enter formulas for the surface areas in cells D2 and E2.

Step 3 You can compare the surface areas of the cubes by dividing the surface area of the new cube by the surface area of the original cube. Enter a formula for this ratio.

Step 4 Change the original value of the side length and see what happens to the ratio. Do this several times until you see a pattern.

Use a spreadsheet to help you answer each question.

1. What happens to the surface area of a cube when the side length is doubled?

2. What happens to the surface area of a cube when the side length is tripled?

3. What happens to the surface area of a cube when the side length is quadrupled?

4. What happens to the surface area of a cube when the side length is multiplied by *n*? Explain your answer.