



Volume, Lateral, and Total Surface Area of a Cylinder

Grade 8 | Module 5 | Topic 4 | Lesson 1

Objectives

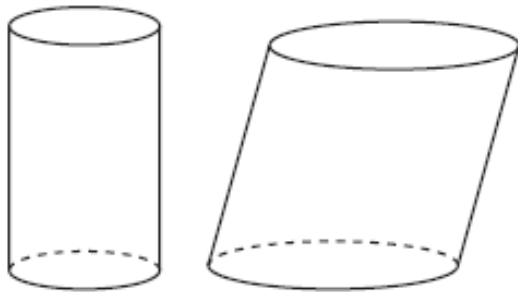


- Explore the volume of a cylinder.
- Write formulas for the volume of a cylinder.
- Use a formula to determine the volume of cylinders in mathematical and real-world problems.
- Use the formula for the volume of a cylinder to solve for unknown dimensions.
- Explore the lateral and total surface area of a cylinder.
- Use the formulas for the lateral and total surface area of a cylinder to solve real-world problems.

Key Terms

cylinder [cilindro]: is a three-dimensional object with two parallel, congruent circular bases

Examples



Key Terms

right cylinder [cilindro recto]: is a cylinder in which the bases are aligned one directly above the other

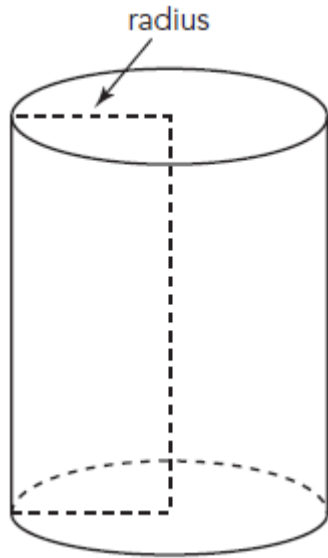
Example



Key Terms

radius of a cylinder [radio de un cilindro]: is the distance from the center of the base to any point on the edge of the base. The radius of a cylinder is the same on both bases

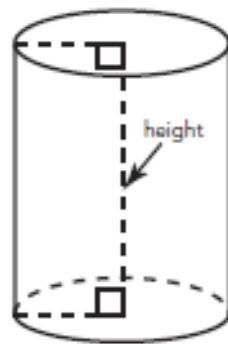
Example



Key Terms

height of a cylinder: is the length of a line segment drawn from one base to the other base, perpendicular to both bases

Example





Essential Question

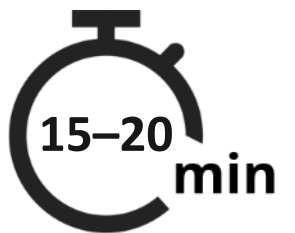
You know how to calculate the area of circles and the volume of rectangular prisms and pyramids.

How can you use this knowledge to solve problems involving the volume, lateral surface area, and total surface area of cylinders?



Day 1

Getting Started



All About Cylinders

A **cylinder** is a three-dimensional object with two parallel, congruent circular bases.

1. Sketch an example of a cylinder. Explain how your sketch fits the definition of a cylinder.

All About Cylinders

Ask Yourself:

How else can you represent this information?

2. Compare your sketch with your classmates' sketches. Did everyone sketch the same cylinder? Explain how the sketches are the same or different.

All About Cylinders

3. A **right cylinder** is a cylinder in which the bases are circles and are aligned one directly above the other. Consider your sketch. Does your sketch look like a right cylinder?

All About Cylinders

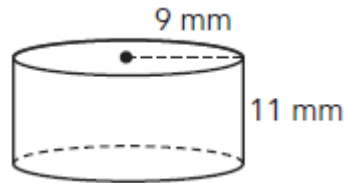
The **radius of a cylinder** is the distance from the center of the base to any point on the edge of the base. The radius of a cylinder is the same on both bases. The **height of a cylinder** is the length of a line segment drawn from one base to the other base, perpendicular to both bases.

4. Use your sketch to illustrate the radius and height of a cylinder.

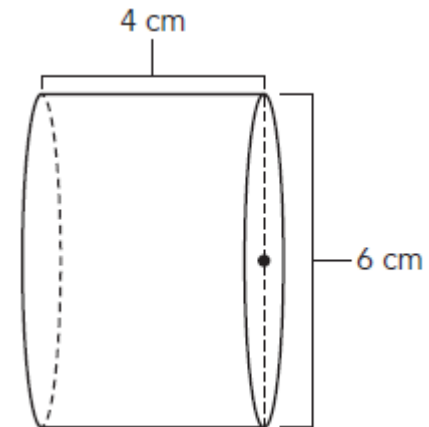
All About Cylinders

5. Identify the radius, diameter, and height of each cylinder. Shade the 2 bases of each cylinder.

a.



b.



All About Cylinders

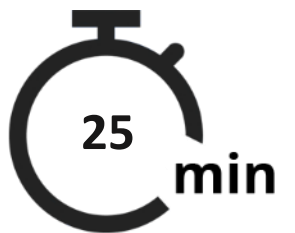


Let's summarize our learning from the Getting Started!



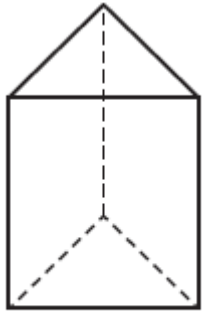
All About Cylinders

Activity 1.1

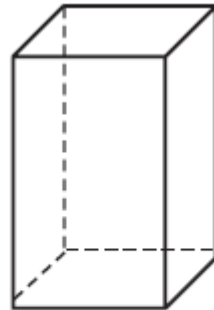


Volume Formula for a Cylinder

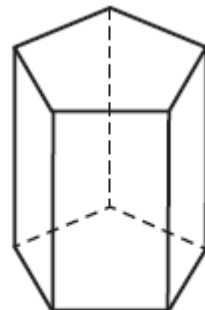
Analyze the prisms shown.



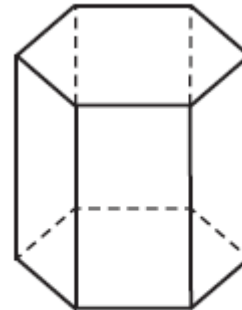
Triangular Prism



Rectangular Prism



Pentagonal Prism



Hexagonal Prism

1. What do you notice as the number of sides of the base increases?

Volume Formula for a Cylinder

Prisms and cylinders both have two bases and a constant height between the bases.

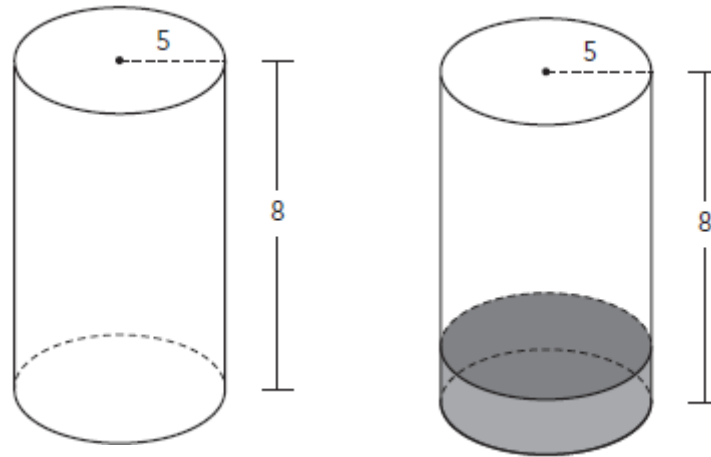
2. Because cylinders and prisms are similar in composition, their volumes are calculated in similar ways.
 - a. Write the formula for the volume of any right prism. Define all variables used in the formula.

Volume Formula for a Cylinder

- b. Make a conjecture about how you will calculate the volume of a right cylinder.

Volume Formula for a Cylinder

Consider the cylinder shown. The length of the radius of the circular base is 5 units and the height of the cylinder is 8 units.



Volume Formula for a Cylinder

3. Suppose there is a circular disc of height 1 unit at the bottom of the cylinder.
 - a. Calculate the area of the top of the circular disc.
 - b. How many congruent circular discs would fill the cylinder? What is the volume of each disc? Explain your reasoning.

Recall these formulas for circles.

$$A = \pi r^2$$

$$C = 2\pi r$$



Volume Formula for a Cylinder

- c. Determine the total volume of the cylinder. Explain your strategy.

Volume Formula for a Cylinder

4. Write a formula for the volume of a cylinder, where V represents the volume of the cylinder, r represents the radius of the cylinder, and h represents the height of the cylinder.

How is this formula like the volume formula for prisms?



Volume Formula for a Cylinder



Let's revisit the Essential Question and summarize our learning from Activity 1.1!

Essential Question: How can you use this knowledge to solve problems involving the volume, lateral surface area, and total surface area of cylinders?



Volume Formula for a Cylinder



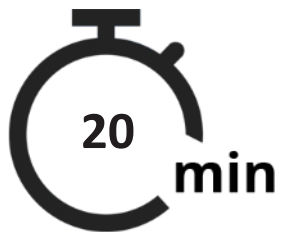
Day 2



Essential Question

How can you use this knowledge to solve problems involving the volume, lateral surface area, and total surface area of cylinders?

Activity 1.2



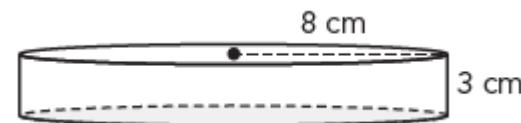
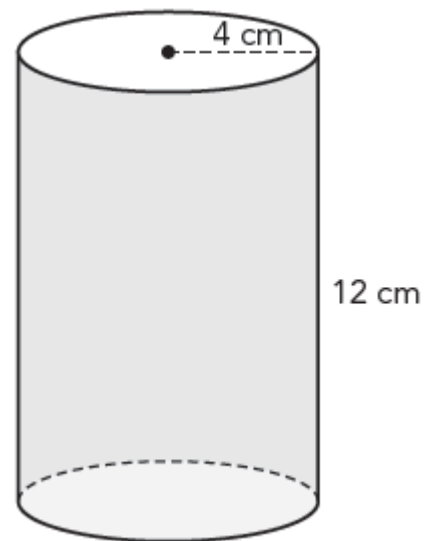
Cylinder Volume Problems

The director of the marketing department at a rice-packing factory sent a memo to her product development team. She requested that the volume of the new cylinder prototype be approximately 603.19 cm^3 .

Cylinder Volume Problems



1. Two members of the marketing team claim to have created appropriate prototypes, but they disagree about the dimensions of the cylinder prototype. Jasmine designed the cylinder prototype on the left, and Lucas designed the cylinder prototype on the right. Who is correct? What would you say to Jasmine and Lucas to settle their disagreement?



Cylinder Volume Problems

Use what you know about cylinders to solve real-world problems.
Round to the nearest hundredth.

2. A circular swimming pool has a diameter of 30 feet and a depth of 5 feet. What is the volume of the pool?

Cylinder Volume Problems

3. How many milliliters of liquid are needed to fill a cylindrical can with a radius of 3 centimeters and a height of 4.2 centimeters?

One milliliter is equivalent to one cubic centimeter of liquid.

Cylinder Volume Problems

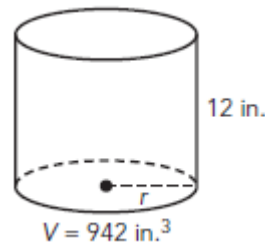
4. Many newspapers are made from 100% wood. The wood used to make this paper can come from pine trees, which are typically about 60 feet tall and have diameters of about 1 foot. However, only about half of the volume of each tree is turned into paper. Suppose it takes about 0.5 cubic inches of wood to make one sheet of paper. About how many sheets can be made from a typical pine tree? Show your work and explain your reasoning.



Cylinder Volume Problems

WORKED EXAMPLE

You can use the formula for the volume of a cylinder to determine unknown dimensions.



$$V = Bh$$

Use the formula for the volume of a cylinder.

$$V = \pi r^2 h$$

Substitute πr^2 for B to represent the circular base.

$$942 = \pi r^2(12)$$

Substitute known dimensions into formula.

Cylinder Volume Problems

WORKED EXAMPLE

$942 \approx 37.70r^2$ Rewrite expression in lowest terms. Round to the nearest hundredth.

$$25 \approx r^2$$

Isolate the unknown dimension.

$$\sqrt{25} \approx r$$

Solve for the unknown dimension.

$$5 \approx r$$

The radius of the cylinder is approximately 5 inches.

Cylinder Volume Problems

5. Analyze the Worked Example. Assume you have been given the total volume of the cylinder.
 - a. What additional information would you need to determine the radius?
 - b. What additional information would you need to determine the height?

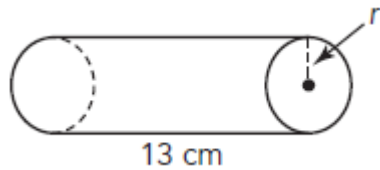
Cylinder Volume Problems

6. Determine the diameter of the cylinder for the Worked Example.
7. Explain why the unit of measure for the radius in the Worked Example is NOT cubic inches.

Cylinder Volume Problems

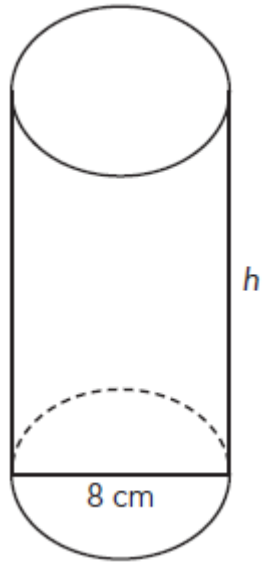
8. The volume of each solid is 500 cm^3 . Calculate the unknown dimension in each figure. Round to the nearest hundredth.

a.

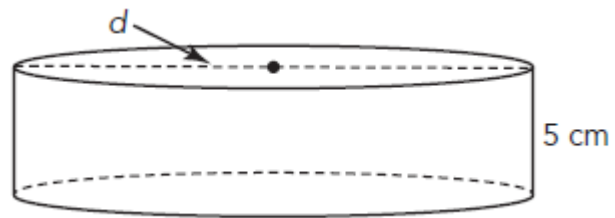


Cylinder Volume Problems

b.



c.



Cylinder Volume Problems

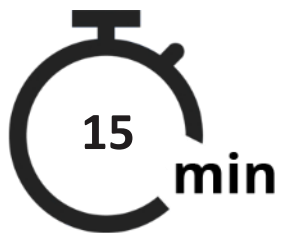


Let's summarize our learning from Activity 1.2!



Cylinder Volume Problems

Activity 1.3



Lateral and Total Surface Area of a Cylinder

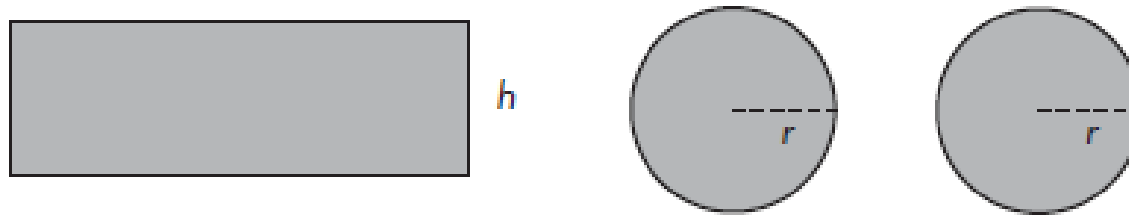
Consider the right cylinder shown.

The total surface area is the sum of the areas that form the surface of a three-dimensional figure. The label of a can covers the surface of the can that does not include the two bases that are circles. You call this *lateral surface area*. If you cut the label from a can, you can see that the label is a rectangle.



Lateral and Total Surface Area of a Cylinder

The width of the rectangle is the height of the can. Because the label wraps around the can, the length of the rectangle is the circumference of the can. The total surface area of the can is the area of the rectangle plus the area of the two circular bases.



Lateral and Total Surface Area of a Cylinder

You can use S_T and S_L to distinguish between the formulas for the total and lateral surface area of a cylinder.

1. Label the base of the rectangle.
2. Write an expression to model the area of each face.

Lateral and Total Surface Area of a Cylinder

3. Write the formula for the lateral surface area of the cylinder.
Explain your reasoning.

Lateral and Total Surface Area of a Cylinder

4. Write the formula for the total surface area of the cylinder.
Explain your reasoning.

Lateral and Total Surface Area of a Cylinder

5. How are the formulas for lateral surface area and total surface area of a cylinder related?

Lateral and Total Surface Area of a Cylinder

6. A cylindrical paint roller has a length of 10 inches and a radius with a length of 1.25 inches. Apply the formula to determine the lateral surface area of the paint roller. Round to the nearest hundredth.

Lateral and Total Surface Area of a Cylinder

7. A snare drum has a height of 5.5 inches and a diameter of 14 inches. Calculate the total surface area of the drum. Round to the nearest hundredth.

Lateral and Total Surface Area of a Cylinder



Let's summarize our learning from Activity 1.3!



Lateral and Total Surface Area of a Cylinder

Talk the Talk



The Prism Connection

Luna was absent for the lesson on volume of a cylinder. However, she knows that the formula for the volume of a right rectangular prism can be written as $V = lwh$. Explain to Luna how to use her knowledge of the volume of right rectangular prisms to determine the volume of a cylinder.

The Prism Connection



Let's answer the Essential Question and summarize our learning from the Talk the Talk!

Essential Question: How can you use this knowledge to solve problems involving the volume, lateral surface area, and total surface area of cylinders?



The Prism Connection



Prepare

Prepare for Module 5 Topic 4 Lesson 2

Calculate the length of the hypotenuse given the two legs of a right triangle.

1. $r = 4.5 \text{ cm}, s = 6 \text{ cm}$

2. $a = 16 \text{ m}, b = 24 \text{ m}$

Prepare for Module 5 Topic 4 Lesson 2

3. $h = 2.7 \text{ in.}, j = 3.9 \text{ in.}$

4. $x = 0.59 \text{ yd}, y = 1.41 \text{ yd}$

Acknowledgment

Thank you to all the Texas educators and stakeholders who supported the review process and provided feedback. These materials are the result of the work of numerous individuals, and we are deeply grateful for their contributions.

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