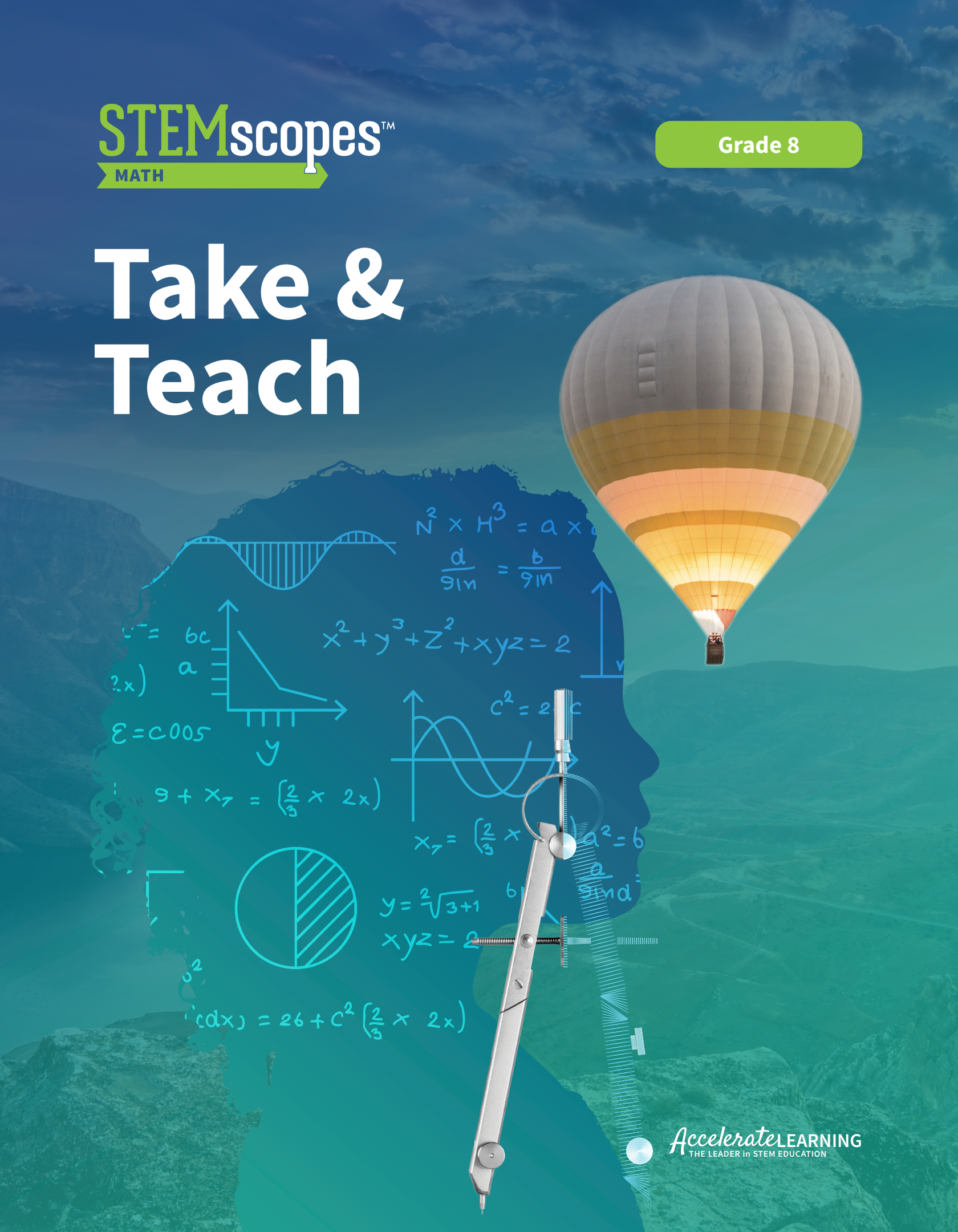
STEMscopes™ MATH

Grade 8

Take & Teach



AccelerateLEARNING
THE LEADER in STEM EDUCATION

What's Inside This Sample Lesson?

- A fully guided **Explore activity** written to meet rigorous state and national standards
- **Teacher Edition** pages, **Student Workbook** pages, and **other helpful resources** to fully experience a STEMscopes Math Explore activity

Table of Contents

Grade 8, Volume - Explore 2

Go Online!

Explore the digital resources for this lesson.

GRADE 8

VOLUME

FOCUS STANDARDS

Solve real-world and mathematical problems involving volume of cylinders, cones and spheres.

- Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world or mathematical problems.

ENGAGE ACTIVITIES

ACCESSING PRIOR KNOWLEDGE - DOES NOT BELONG

Students will engage in identifying which rectangular prism does not belong in a given group to uncover and address misconceptions about volume.

- Students receive a handout with groups of four options, identifying the one that does not fit and explaining their reasoning.
- The activity focuses on understanding the correct application of the volume formula for rectangular prisms.
- Teachers facilitate discussions to clarify misconceptions, such as confusing surface area with volume or incorrectly calculating volume.
- If needed, additional foundational support is provided to strengthen students' understanding before progressing further.

HOOK

Students explore the concept of volume by applying formulas to determine the volume of cylinders, cones, and spheres.

- Students are introduced to a real-world scenario involving a sculpture and are tasked with calculating the amount of clay needed.
- They engage with visual aids and class discussions to identify mathematical concepts and problem-solving strategies.
- After completing exploratory activities, students revisit the scenario to apply their newly acquired knowledge to calculate volumes using specific formulas.
- The activity encourages critical thinking by having students experiment with changing dimensions and observing the effects on volume.

EXPLORE ACTIVITIES

EXPLORE 1 - CYLINDERS

Students explore and apply the formula for the volume of a cylinder through hands-on and collaborative exercises.

- Students work in pairs to construct a cylinder using a net and centimeter cubes, discovering how to calculate its volume by relating it to the volume of a rectangular prism.
- They solve mathematical and real-world problems involving the radius, base, height, and volume of cylinders, using guiding questions and structured conversations to deepen understanding.
- Students engage in a Math Chat to share observations and strategies, enhancing their comprehension of the volume formula and its applications.
- The activity concludes with an Exit Ticket and reflection to assess understanding and reinforce learning.

JUMP IN HERE

EXPLORE 2 - CONES

Students explore the concept of volume by discovering the formula for the volume of a cone and applying it to solve problems.

- Students work in groups to create physical models of cones and cylinders using nets, rice, and other materials to understand the relationship between their volumes.
- Through guided questions and hands-on experimentation, students derive the formula for the volume of a cone and compare it to the volume of a cylinder.
- Students apply their understanding by solving real-world problems using the volume formula, enhancing their problem-solving skills and mathematical reasoning.
- The activity concludes with a Math Chat and reflection, allowing students to share insights and reinforce their learning.

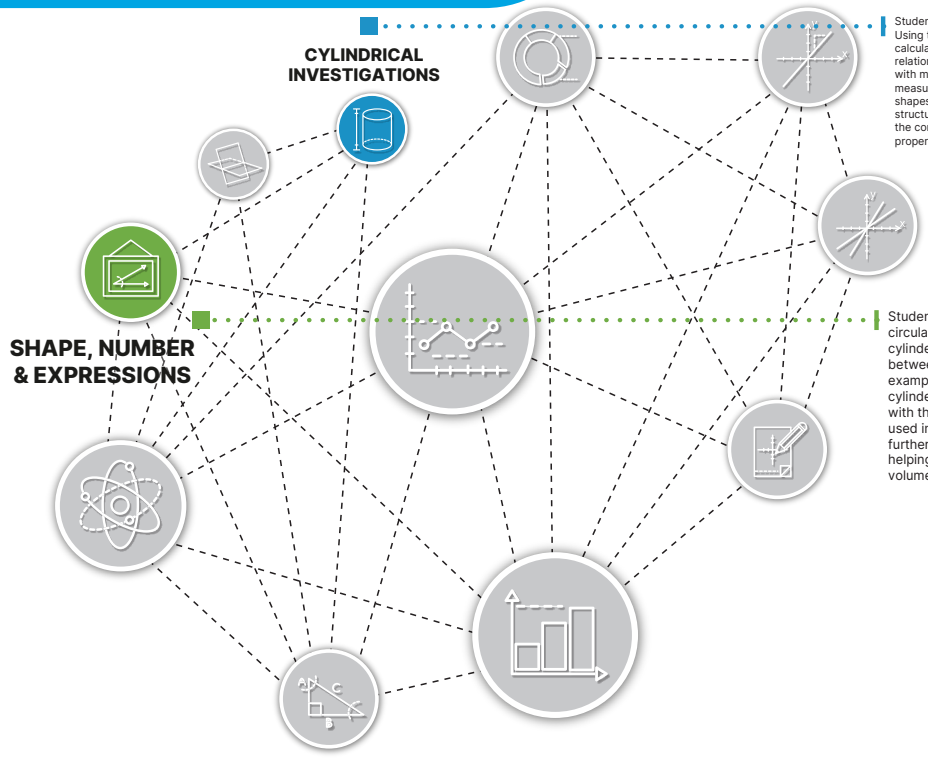
EXPLORE 3 - SPHERES

Students explore the concept of volume by focusing on spheres and applying mathematical formulas to solve problems.

- Students work in groups to discover the formula for the volume of a sphere using rice and geometric shapes, comparing it with the volume of cones and cylinders.
- They engage in hands-on activities to fill a sphere with rice and relate it to the volume of a cone and cylinder, enhancing their understanding through guided questions.
- Students apply the volume formula for spheres to solve real-world problems, using Juice It Cards to model and calculate the volume of spherical fruits.
- The lesson concludes with a Math Chat to discuss observations, strategies, and the relationship between the volumes of different geometric shapes.

VOLUME **GRADE 8**

SCOPE **BIG IDEAS**



Students explore the volume of cylinders by solving real-world problems. Using the formula for the volume of a cylinder, $V = \pi r2h$, students calculate the volume of cylindrical objects, such as cans, by applying the relationships between the base area (a circle) and height. They engage with models, such as a cylinder net, and use tools like rice to physically measure and visualize how volume is distributed within cylindrical shapes. This hands-on approach helps students understand how the structure of a cylinder influences the calculation of its volume, reinforcing the connection between volume, surface area, and the geometric properties of the figure.

Students compare shapes, particularly focusing on how circular shapes relate to prisms. By analyzing the volume of cylinders, cones, and spheres, they explore the connections between integer exponents and volume calculations. For example, students use the formula for the volume of a cylinder, $V = \pi r2h$, to connect the area of the circular base with the height of the cylinder, reinforcing how exponents are used in real-world volume calculations. This understanding is further extended to comparing the volume of various shapes, helping students recognize patterns in how dimensions affect volume in both circular and prismatic forms.

KEY CONCEPTS

- I can derive the volume formula for cones, cylinders, and spheres.
- I can use the volume formulas for cones, cylinders, and spheres to solve real-world and mathematical problems.
- I can use inverse operations to solve for different variables (e.g., volume, height, radius) within the volume formulas for cones, cylinders, and spheres.

FUNDAMENTAL QUESTIONS

- Define the volume formulas for cones, cylinders, and spheres.
- When might inverse operations be used to solve for missing pieces of a volume problem?
- Describe the process of using the volume formulas for cones, cylinders, and spheres.

SCAN HERE for the Teacher Prep Video

INSTRUCTIONAL LESSON

EXPLORE 2 - CONES

Standard(s)

- **Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.** Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

Big Ideas	Standards for Mathematical Practice	Content Connections	Drivers of Investigation
Cylindrical Investigations Shape, Number & Expressions	**MP.2** Reason abstractly and quantitatively. **MP.4** Model with mathematics. **MP.5** Use appropriate tools strategically. **MP.7** Look for and make use of structure.	**CC3** Taking Wholes Apart, Putting Parts Together **CC4** Discovering Shape and Space	**DI1** Make Sense of the World (Understand and Explain)

DESCRIPTION

Students will discover the formula for the volume of a cone and solve mathematical and real-world problems to find the volume of a cone.

MATERIALS

PRINTED

- 1 Student Journal (per student)
- 1 Set of Cone It Cards (per group)
- 1 Cylinder and Cone Nets (per group)
- 1 Exit Ticket (per student)

REUSABLE

- 1 Resealable bag (per group)
- 1 Pair of scissors (per teacher)
- 1 Glue stick (per group)

CONSUMABLE

- 1 Bag of rice (per group)

PREPARATION

- Plan to divide the class into groups of 3 or 4 to complete the activity.
- Print a Student Journal and Exit Ticket for each student.
- Print one Cylinder and Cone Nets for each group of students. If desired, print them on card stock.
- Print a set of Cone It Cards for each group of students. If desired, print them on card stock and laminate for future use. Cut out the cards, and put them in a resealable bag for each group.

PROCEDURE AND FACILITATION POINTS

PART I: UNDERSTANDING THE VOLUME OF A CONE FORMULA

1. Read the following scenario: *Madeline's family added another fun component to their farm. The Dupont family purchased dairy cows and started making ice cream. They built an ice cream parlor on their farm. They package the ice cream in cylinder containers. They serve it only in cones and only fill the cones until they are full to the level of the opening because this prevents dripping and messes. The Duponts would like to know how to find the volume of the cones so they know how many cones can be served from each cylindrical container. Your job today is to discover a formula for the volume of a cone.*
2. Give one copy of the Cylinder and Cone Nets, a pair of scissors, a glue stick, and a bag of rice to each group.
3. Explain to students that they will work in their groups to discover the formula for volume of a cone by using what they know about the formula for the volume of a cylinder. (*Note: They will look at models of a cone and a cylinder with congruent bases and identical heights.*)
4. Have students cut out the cylinder and cone nets to create the cylinder and cone. (*Note: Make sure students understand that the base of the cone and one of the bases of the cylinder should be open so that rice can be poured in both figures*). Once the cylinder and cone have been created, have students fill the cone with rice to the top with a level surface and pour it into the cylinder. They will repeat this process and see how many times it takes until the cylinder is full right to the top with a level surface. Monitor and assess student understanding as each group collaborates by asking the following guiding questions:
   a. **DOK-1** How are a cone and a cylinder similar? Student responses will vary. They are both 3-D figures and both have a circular base and are curved.

   b. **DOK-1** How are a cone and a cylinder different? Student responses will vary. A cone has only one base and an apex, while a cylinder has two bases.
   c. **DOK-1** What do you notice about the bases of the cylinder and the cone? Student responses will vary. They are congruent, and they are circles.
   d. **DOK-1** What do you notice about the heights of the cone and the cylinder? Student responses will vary. They are equal.
   e. **DOK-1** Did the cylinder and the cone hold equal volumes of rice? If not, which held more? The cylinder and the cone do not hold equal volumes of rice. The cylinder holds more rice than the cone.
   f. **DOK-1** How many times were you able to fill the cylinder with rice from the cone? Three times

5. After Part I, invite the class to a Math Chat to share their observations and learning.

MATH CHAT

- **DOK-1** What is the formula for the volume of a cylinder? Volume = Bh or $V = \pi r^2 h$
- **DOK-2** What is the volume of a cone compared to the volume of a cylinder with a congruent base and an equal height? A cone has ⅓ the volume of a cylinder with a congruent base and an equal height.
- **DOK-2** What is the formula for the volume of a cone? Volume = $\frac{1}{3} \pi r^2 h$

PART II: SOLVING VOLUME OF A CONE PROBLEMS

1. Read the following scenario: *The Dupont family is adding a big menu board behind the counter at their ice cream parlor on the farm. Each menu item will be described. It is half advertisement and half information. The menu is almost ready to be completed and hung, but the family is missing one piece of information about the size of each cone. Your job is to use the formula for the volume of a cone to determine the missing information regarding the different sizes of cones the Dupont family sells. The missing information might be the radius or diameter of the opening, the area of the opening, the height of the cone, or the volume of ice cream the cone holds when filled to exactly the level of the opening. This information will allow customers to select the best size cone for their situations, creating more satisfied customers.*
2. Give a Student Journal to each student.
3. Give a bag containing a set of Cone It Cards to each group.
4. Explain to students that they will work in their groups to find the volume of a cone. Instruct students to use the information on the Cone It Cards and find the volume of each cone.
5. Have students draw a model of the cone and label its dimensions and then find the area of the base, express the area in terms of π, and find the volume of the cone. Monitor and assess student understanding as each group collaborates by asking the following guiding questions
   a. **DOK-1** What happens to the volume of a cone as its height increases? Student responses will vary. Volume increases.
   b. **DOK-1** What happens to the volume of the cone when the radius increases? Volume increases.
   b **DOK-1** How do you find the volume of a cone? We use the volume formula for a cone ($\frac{1}{3} \pi r^2 h$) and plug in the radius and height.
   c. **DOK-2** How do you find the height or the radius of a cone? We use the volume formula but solve for radius or height.
6. Allow time for students to complete Part II of the Student Journal, including the reflection questions.
7. After Part II, invite the class to a Math Chat to share their observations and learning.

MATH CHAT

- **DOK-2** Which affects the volume of a cone more—increasing the radius or increasing the height? Why? Increasing the radius affects the volume of the cone more than the increasing height because the radius is squared to find the volume.
- **DOK-2** What did you notice about the relationship between the height and the volume of a cone? The greater the height, the greater the volume of the cone.
- **DOK-2** Do you think the relationship between the volume of a cylinder and the volume of a cone would work if the radii and heights are not the same? Explain. No, in order for the volume of a cone to represent ⅓ of the volume of a cylinder, the radius and the height must be the same.
- **DOK-2** What other real-world situations would require people to know the volume, height, or radius of cones? Answers will vary. What is the height of traffic cones so people can see them and not run over them? What is the radius/diameter of a conifer Christmas tree to know whether it will fit in a living room? What is the volume of cone-shaped paper water cups to make sure we serve enough water to athletes playing in the heat?

8. When students are done, have them complete the Exit Ticket to formatively assess their understanding of the concept.

ANCHOR CHART AND INTERACTIVE NOTEBOOK

- Be sure to complete the Anchor Chart as a class. Once the class has completed the Anchor Chart, have students individually complete their Interactive Notebook.

INSTRUCTIONAL SUPPORTS

1. If students struggle to visualize the dimensions of a model, encourage them to draw the model and label its dimensions. This practice will help them properly visualize the model and give them insight into how to apply the given information.
2. Students who are rushing through the work and plugging in values for radius by rote, may mistakenly plug in the value of diameter for the radius. Encourage students to read the problem carefully, draw and label their diagrams accordingly, and then solve.

Explore

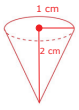
Volume
Explore 2

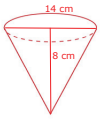
Name:_____ Date:_____

Cone It!

Part II

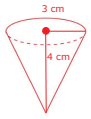
Use the Cone It Cards to complete the table. Draw a model of each cone, and label the dimensions. Use the workspace to represent the area of the base expressed in terms of π, and then find the volume. Use 3.14 as an approximation for π. Round to the nearest hundredth, if necessary.

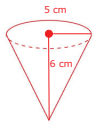
Sample Cone	
Model: 	Workspace: $V = \frac{1}{3}Bh$ B (Area of the Base): $\pi 1^2 = 1\pi$ $h = 2$ $V = \frac{1}{3}2\pi = \frac{2}{3}\pi$ $V = 2.09$
Volume: 2.09 cm³	

Medium Cone	
Model: 	Workspace: $V = \frac{1}{3}Bh$ B (Area of the Base): $\pi 7^2 = 49\pi$ $h = 8$ $V = \frac{1}{3}392\pi = 130.67\pi$ $V = 410.30$
Volume: 410.30 cm³	

Explore

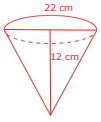
Volume
Explore 2

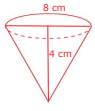
Kiddie Cone	
Model: 	Workspace: $V = \frac{1}{3}Bh$ B (Area of the Base): $\pi 3^2 = 9\pi$ $h = 4$ $V = \frac{1}{3}36\pi = 12\pi$ $V = 37.68$
Volume: 37.68 cm³	

Small Cone	
Model: 	Workspace: $V = \frac{1}{3}Bh$ B (Area of the Base): $\pi 5^2 = 25\pi$ $h = 6$ $V = \frac{1}{3}150\pi = 50\pi$ $V = 157$
Volume: 157 cm³	

Explore

Volume
Explore 2

Waffle Cone	
Model: 	Workspace: $V = \frac{1}{3}Bh$ B (Area of the Base): $\pi 11^2 = 121\pi$ $h = 12$ $V = \frac{1}{3}1{,}452\pi = 484\pi$ $V = 1{,}519.76$
Volume: 1,519.76 cm³	

Teeny Tiny Sundae Cone	
Model: 	Workspace: $V = \frac{1}{3}Bh$ B (Area of the Base): $\pi 4^2 = 16\pi$ $h = 4$ $V = \frac{1}{3}64\pi = 21.33\pi$ $V = 66.98$
Volume: 66.98 cm³	

Explore

Volume
Explore 2

Reflect

1. What did you notice about the relationship between the height and the volume of a cone?

   The greater the height of the cone is, the greater the volume of the cone is.

2. What did you notice about the relationship between the radius and volume of a cone?

   The greater the radius is, the greater the volume of the cone is.

3. Do you think the relationship between the volume of a cylinder and the volume of a cone would work if the radii and heights were not the same? Explain.

   No, in order for the volume of a cone to represent $\frac{1}{3}$ of the volume of a cylinder, the radius and the height must be the same.

STUDENT JOURNAL
ANSWER KEY

GRADE 8 VOLUME

EXPLORE > EXPLORE 2

LANGUAGE ACQUISITION SUPPORTS

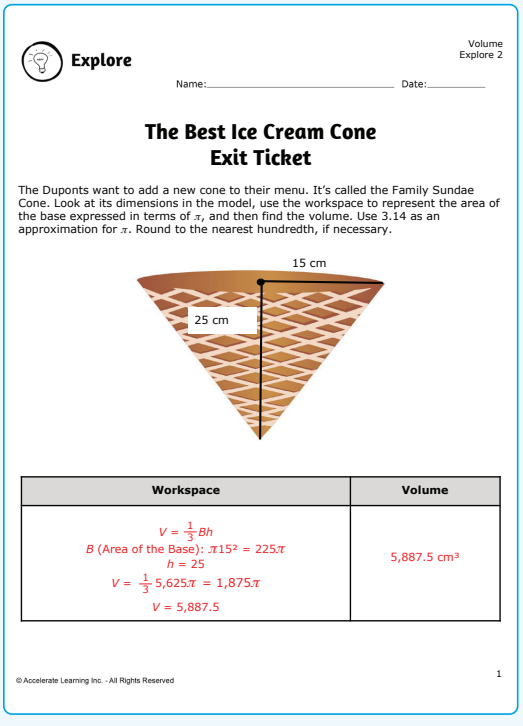
The following Language Acquisition Strategy is supported in this Explore activity. See the strategies below for ways to support a student's language development.

Students will use visual cues, peers, and teachers to develop vocabulary, language structure, and background knowledge needed to comprehend written text.

Beginner: As a pre-lesson activity, project an image on the board and highlight within the image something that is a cone shape. Ask students: How many cone-shaped things can you find in this image? Help students pronounce any names they may not know.

Intermediate: As a pre-lesson activity, have available three to four everyday objects that are cone shape (e.g. an ice cream cone, traffic cone, party hat, etc.). Allow students to handle the objects. Then ask what do all of these objects have in common? (i.e., they are all cone shape). Project the name and image of a cylinder on the board, and ask the class what other objects they know that are cylinder-shaped.

Advanced: As a pre-lesson activity, provide pairs of students with an image that has different shaped items. They will work with their partners to list all the cone-shaped items they can identify. Time the activity if you choose and the team with the most items identified in the allotted wins.



Explore

Volume
Explore 2

Name:_____ Date:_____

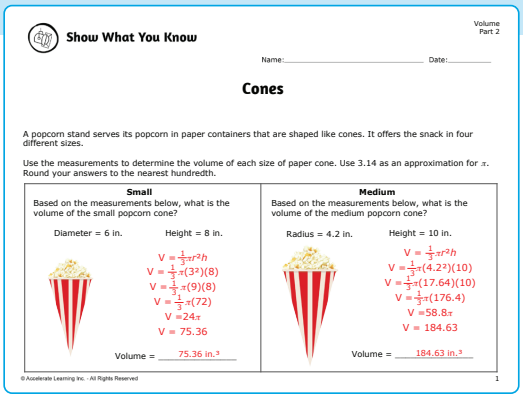
The Best Ice Cream Cone
Exit Ticket

The Duponts want to add a new cone to their menu. It's called the Family Sundae Cone. Look at its dimensions in the model, use the workspace to represent the area of the base expressed in terms of π, and then find the volume. Use 3.14 as an approximation for π. Round to the nearest hundredth, if necessary.

Workspace	Volume
$V = \frac{1}{3}Bh$ B (Area of the Base): $\pi 15^2 = 225\pi$ $h = 25$ $V = \frac{1}{3}5{,}625\pi = 1{,}875\pi$ $V = 5{,}887.5$	5,887.5 cm³

1

EXIT TICKET
ANSWER KEY



Show What You Know

Volume
Part 2

Name:_____ Date:_____

Cones

A popcorn stand serves its popcorn in paper containers that are shaped like cones. It offers the snack in four different sizes.

Use the measurements to determine the volume of each size of paper cone. Use 3.14 as an approximation for π. Round your answers to the nearest hundredth.

Small

Based on the measurements below, what is the volume of the small popcorn cone?

Diameter = 6 in. Height = 8 in.

$V = \frac{1}{3}\pi r^2 h$
$V = \frac{1}{3}\pi(3^2)(8)$
$V = \frac{1}{3}\pi(9)(8)$
$V = \frac{1}{3}\pi(72)$
$V = 24\pi$
$V = 75.36$

Volume = 75.36 in.³

Medium

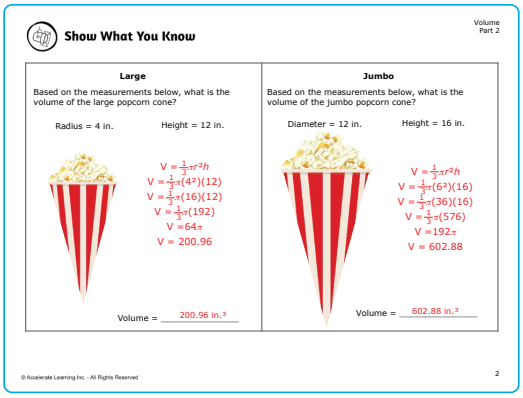
Based on the measurements below, what is the volume of the medium popcorn cone?

Radius = 4.2 in. Height = 10 in.

$V = \frac{1}{3}\pi r^2 h$
$V = \frac{1}{3}\pi(4.2^2)(10)$
$V = \frac{1}{3}\pi(17.64)(10)$
$V = \frac{1}{3}\pi(176.4)$
$V = 58.8\pi$
$V = 184.63$

Volume = 184.63 in.³

1



Show What You Know

Volume
Part 2

Large

Based on the measurements below, what is the volume of the large popcorn cone?

Radius = 4 in. Height = 12 in.

$V = \frac{1}{3}\pi r^2 h$
$V = \frac{1}{3}\pi(4^2)(12)$
$V = \frac{1}{3}\pi(16)(12)$
$V = \frac{1}{3}\pi(192)$
$V = 64\pi$
$V = 200.96$

Volume = 200.96 in.³

Jumbo

Based on the measurements below, what is the volume of the jumbo popcorn cone?

Diameter = 12 in. Height = 16 in.

$V = \frac{1}{3}\pi r^2 h$
$V = \frac{1}{3}\pi(6^2)(16)$
$V = \frac{1}{3}\pi(36)(16)$
$V = \frac{1}{3}\pi(576)$
$V = 192\pi$
$V = 602.88$

Volume = 602.88 in.³

2

SHOW WHAT YOU KNOW - PART 2
ANSWER KEY

Explore

Volume
Explore 2

Name:_____ Date:_____

Cone It!

Part II

Use the Cone It Cards to complete the table. Draw a model of each cone, and label the dimensions. Use the workspace to represent the area of the base expressed in terms of π, and then find the volume. Use 3.14 as an approximation for π. Round to the nearest hundredth, if necessary.

Sample Cone	
Model:	Workspace:
Volume:	

Medium Cone	
Model:	Workspace:
Volume:	

Explore

Kiddie Cone	
Model:	Workspace:
Volume:	

Small Cone	
Model:	Workspace:
Volume:	

Explore

Waffle Cone	
Model:	Workspace:
Volume:	

Teeny Tiny Sundae Cone	
Model:	Workspace:
Volume:	

Explore

Reflect

1. What did you notice about the relationship between the height and the volume of a cone?

2. What did you notice about the relationship between the radius and volume of a cone?

3. Do you think the relationship between the volume of a cylinder and the volume of a cone would work if the radii and heights were not the same? Explain.

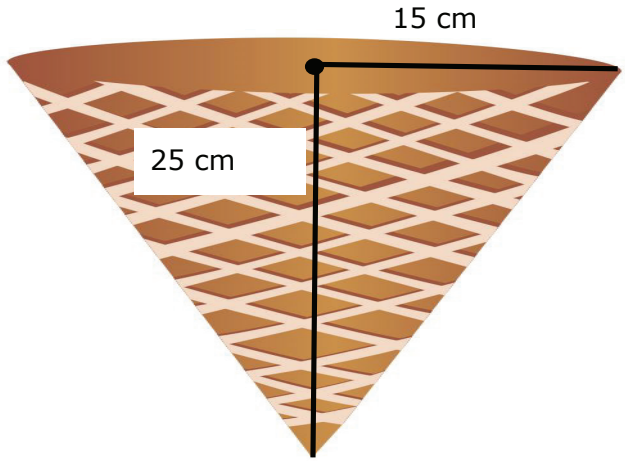
Explore

Volume
Explore 2

Name:_____ Date:_____

The Best Ice Cream Cone
Exit Ticket

The Duponts want to add a new cone to their menu. It's called the Family Sundae Cone. Look at its dimensions in the model, use the workspace to represent the area of the base expressed in terms of π, and then find the volume. Use 3.14 as an approximation for π. Round to the nearest hundredth, if necessary.

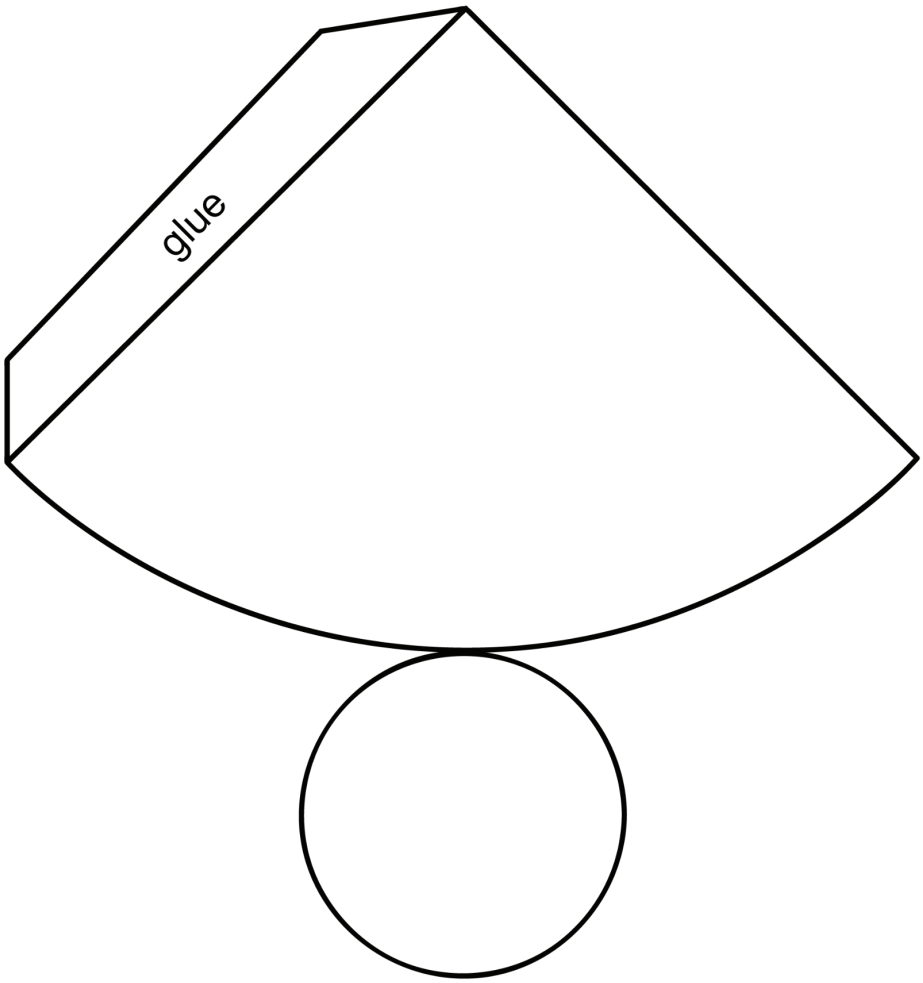


Workspace	Volume

Explore

Volume
Explore 2

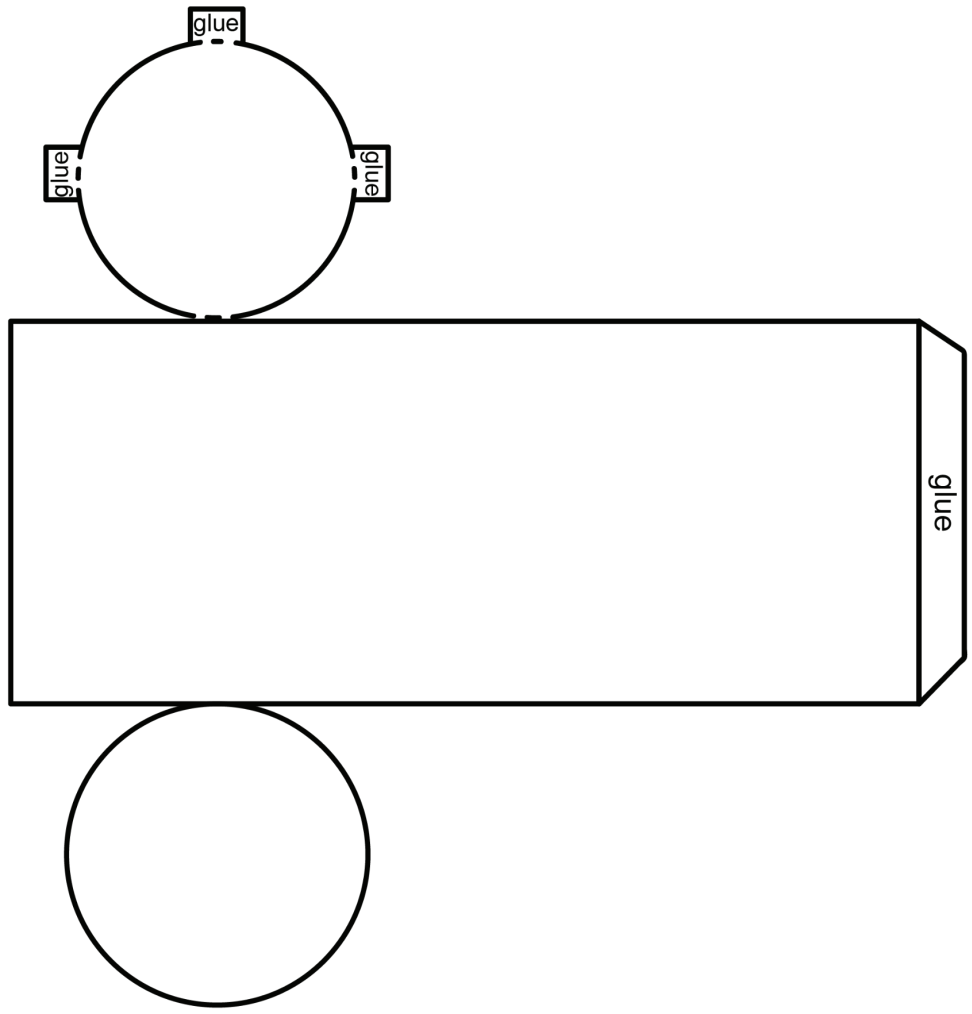
Cone Net



Explore

Volume
Explore 2

Cylinder Net



2

Explore

Volume
Explore 2

Cone It Cards

Sample Cone

Sample cones are made of the same delicious ingredients as our regular cones; they are perfect to get a taste of our delicious ice creams and decide what you want to indulge in today. The sample cone has a height of 2 cm and a radius of 1 cm.

What is the volume of a sample cone?

Medium Cone

It's the middle of the afternoon. You want a yummy snack. The medium cone is what you need! It features a cone that is 8 cm tall with a diameter of 14 cm for its opening—ready to be filled with sweet delicious ice cream.

What is the volume of ice cream that the medium cone can hold?

Kiddie Cone

Kiddie cones are the perfect size for parents who don't want their kids to have too much sugar but still want them to enjoy a delicious treat! They each have a radius of 3 cm and a height of 4 cm.

What is the volume of a kiddie cone?

Explore

Small Cone

The perfect size for an after-dinner treat, the small cone is packed with flavor, with a radius of 5 cm and a height of 6 cm.

What is the volume of a small cone?

Waffle Cone

Waffle cones are perfect for those who love the taste of homemade cones and ice cream. This cone features a diameter of 22 cm and a whopping height of 12 cm and your choice of delicious flavors.

What is the volume of a waffle cone?

Teeny Tiny Sundae Cone

Shorter and wider, like a bowl, the sundae cone is perfect for making a sundae. The teeny tiny sundae cone has ice cream and toppings. It stands at 4 cm tall and has a diameter of 8 cm.

What is the volume of the teeny tiny sundae cone?

Show What You Know

Volume
Part 2

Name:_____ Date:_____

Cones

A popcorn stand serves its popcorn in paper containers that are shaped like cones. It offers the snack in four different sizes.

Use the measurements to determine the volume of each size of paper cone. Use 3.14 as an approximation for π. Round your answers to the nearest hundredth.

Small

Based on the measurements below, what is the volume of the small popcorn cone?

Diameter = 6 in. Height = 8 in.

Volume = _____

Medium

Based on the measurements below, what is the volume of the medium popcorn cone?

Radius = 4.2 in. Height = 10 in.

Volume = _____

Show What You Know

Large

Based on the measurements below, what is the volume of the large popcorn cone?

Radius = 4 in. Height = 12 in.

Volume = _____

Jumbo

Based on the measurements below, what is the volume of the jumbo popcorn cone?

Diameter = 12 in. Height = 16 in.

Volume = _____

Notes

Notes

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