Khan Academy

5th Grade Math

Unit 12: Volume, perimeter, and area

5.4G, 5.4H, 5.6A, 5.6B

Calculating volume, area, and perimeter enables students to understand and interact with the world—including everyday tasks like packing, decorating, baking, and building.

- ☐ Find the **volume** of 3D shapes constructed of cubes
- ☐ Calculate the **volume** of rectangular prisms
- ☐ Calculate the **area and perimeter** of rectangles

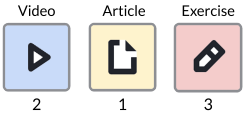
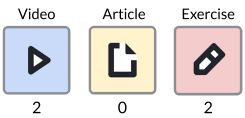
TEKS standards	Common misconceptions
5.4G: Use concrete objects and pictorial models to develop the formulas for the volume of a rectangular prism, including the special form for a cube ($V = l \times w \times h$, $V = s \times s \times s$, and $V = Bh$)	**Confusion between area and perimeter |** Students often get mixed up with area and perimeter. Sometimes they will find the perimeter when they are asked for the area and vice versa. **How to help:** Students will need lots of practice finding area and perimeter. Encourage them to slow down and read each problem carefully so they know what they are being asked to find. Students are usually familiar with the idea of area since it is commonly used in everyday language ("What area of the city do you live in? Let's play in this area!, etc."), though it does need to be formalized. The word perimeter is from Latin meaning "around" (peri) and "measure" (meter). Showing students root words will be helpful so they have tools when they encounter words they are not familiar with. Also, provide clear explanations and visual comparisons of area and perimeter, emphasizing the distinct concepts for each measurement, and offer practice problems to reinforce the differences. If your classroom has tiles on the floor, it can be helpful to outline a rectangle with tape and reference the area (the number of tiles inside the rectangle) and perimeter (the distance to walk around the rectangle). Actually walk around the rectangle to demonstrate the perimeter (and have students walk it, too!). **Confusion between area and volume |** Students might confuse the concept of area with the concept of volume. Area is the space inside a 2D shape while
5.4H: Represent and solve problems related to perimeter and/or area and related to volume	
5.6A: Recognize a cube with side length of one unit as a unit cube having one cubic unit of volume and the volume of a three-dimensional figure as the number	

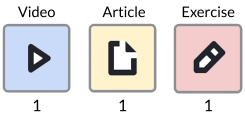
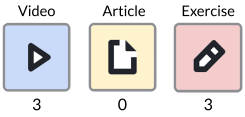
of unit cubes (*n* cubic units) needed to fill it with no gaps or overlaps if possible	volume is the amount of space a 3D shape takes up. **How to help:** It may be helpful to start with a conversation about dimensions, as Sal does in the first video. This will help students to start thinking about length as one dimensional, area as two dimensional, and volume as three dimensional. The discussion will also help students to better understand the units that each dimension is measured in (unit length, unit square, unit cube).
5.6B: Determine the volume of a rectangular prism with whole number side lengths in problems related to the number of layers times the number of unit cubes in the area of the base	**"Order matters in the volume equation for rectangular prisms"** Some students might think that the order in which the length, width, and height are multiplied affects the volume. They might spend a lot of time trying to distinguish which is the length, width, or height, when in fact, for the volume of rectangular prisms, it doesn't matter which dimension is which. **How to help:** It's important to emphasize that, thanks to the commutative property of multiplication, the order doesn't matter. For a review of the commutative property, see the lesson from 3rd grade math. Show students that a rectangular prism can be rotated so that the height is now the width, etc., but the volume remains the same because you are still multiplying the same numbers together and order doesn't matter with multiplication. See "Best practices" below for more information and a visual explanation.

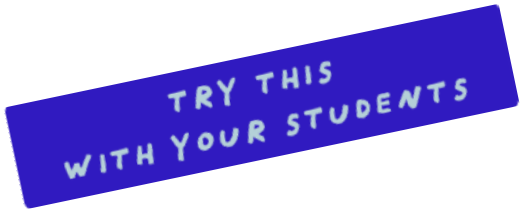
Unit resources

- For the videos in this unit, use the Learning summary video notetaking guide.
- For the articles in this unit, use the Article notetaking guide.
- For the exercises in this unit, use the Blank workspace template.
- To record key terms and information, use the Vocabulary and notation notetaker.

Lesson overview

Lesson	Objective	Teaching tips
Lesson 1: Volume with unit cubes TEKS standard: 5.4H, 5.6A 	Students will be able to find the volume of shapes made of cubic units. Students will be able to find the volume of rectangular prisms by finding the area of a base and multiplying it by the height.	• **Warm up activity:** Have students find the area of various rectangles and squares. In the first video they will be introduced to finding the volume of a cube, so help students make connections between area and volume. • Have examples of cubes (dice, blocks, etc.) and rectangular prisms (different boxes, etc.) on hand as concrete examples. • If you have building blocks or counting cubes, have students build the figures in the first exercise and then count the units. • For problems like those in the second exercise, have students explain to the class how they found the volume using different methods. Using color to show layers can be helpful. There are many ways to calculate volume so let students explore! We do want students to use the equation to find volume in the next lesson, but for now they have time to experiment and formalize a method themselves.
Lesson 2: Volume of rectangular prisms TEKS standard: 5.4G, 5.6B 	Students will be able to find the volume of rectangular prisms using the volume formula.	• The equation for finding the volume of rectangular prisms is formalized in this lesson. Be sure that students understand why it works with a visual model and that the commutative property applies because it doesn't matter how the rectangular prism is rotated, the volume will always be the same. Have students explain it to each other or write about it! • By the end of this lesson, students will be expected to find the volume of rectangular prisms using the formula and also solve for missing lengths (for

		example, given the volume, height, and width, what is the length?). Encourage students to read problems carefully so they know what to find.
Lesson 3: Volume word problems TEKS standard: 5.4H  	Students will be able to solve word problems involving rectangular prisms and their volumes.	• Encourage students to sketch out the problems and label what they are given to help figure out what they are trying to find. • This is a good place for teacher-led groups. The next lesson will include perimeter and area, so have students work on the specific challenges they are having with volume and make sure they get the support they need. The article has a review of what they have learned so far in this unit, so students can use that as a reference.
Lesson 4: Area and perimeter TEKS standard: 5.4H  	Students will be able to find the missing side lengths of rectangles when given the area or perimeter and length of one side.	• **Warm up activity**: Ask students to find the area and perimeter of 2 or 3 rectangles. If students are having a hard time with area, perimeter, or both, that is fine for now! The goal of this activity is to make sure students understand the difference between area (the amount of space covered by a figure—think painting a given figure) and perimeter (the distance around the figure—think walking around the edge of the figure). • The last exercise might be a little tricky for students. They are asked to find a missing dimension given the area or perimeter and one dimension. Sal demonstrates making a table of values to guess and check in the second video. There are multiple methods students could use to solve these problems, so have students share and discuss their methods with the class. • Encourage students to draw a picture of each situation and label it with the information they know. Having an accurate visual representation will make it easier to solve the problem.

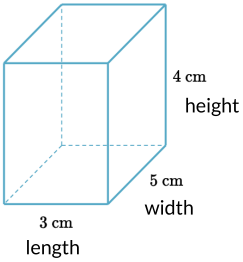


Best practices

Volume formula for rectangular prisms, explained!

The formula for the volume of a rectangular prism is easy to memorize but it's more important to understand *where it comes from*. Knowing how the formula is derived will help to understand how to find the volume of other 3D figures. The idea of finding the area of the base and multiplying that by the height is used to find the volume of any right prism or cylinder, and is related to finding the volume of pyramids. Let's dig deeper.

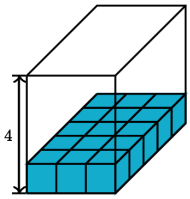
Find the volume of a rectangular prism with dimensions of 3 cm, 4 cm and 5 cm.

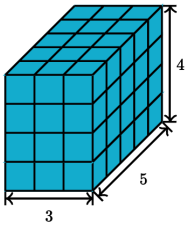


We can label the sides however we wish. If we were to rotate this prism so the base is 4 cm by 5 cm and the height is 3 cm, the volume would still be the same.

First, we will find the area of the base. In this diagram, the base is 3 cm by 5 cm. So, we can fit $3 \times 5 = 15$ cubes at the base.

Second, we will multiply by the height of the prism. Since the height is 4 cm, we will have 4 layers, where each layer contains 15 cubes. We will multiply the number of cubes in the base layer by the number of layers (the height).

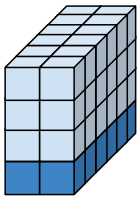




There will be $4 \times 15 = 60$ cubes in the entire figure. So, the volume of a cube with dimensions 3 cm by 4 cm by 5 cm is 60 cm^3. We can also think about this with repeated addition where each layer has 15 cubes, so the volume is $15 + 15 + 15 + 15 = 60$.

Here is an example to see that how we label the length, width, and height of a rectangular prism does not matter when finding the volume:

The dimensions of the three rectangular prisms below are 2 by 4 by 6. The diagrams are each rotated so the bases have different dimensions, but the volumes are always the same.

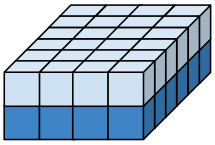


Area of the base × height

$(2 \times 6) \times 4$

12×4

48

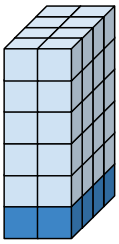


Area of the base × height

$(4 \times 6) \times 2$

24×2

48



Area of the base × height

$(2 \times 4) \times 6$

8×6

48

Working in 3 dimensions
It may be challenging for students to work with three dimensional figures in a two dimensional space like the computer screen or a piece of paper. It's helpful for students to have access to cubes so they can build the figures and work with them physically. As they practice building shapes from a diagram, they will improve their ability to visualize and understand diagrams on paper.

CLASSROOM ACTIVITIES

Volumes of boxes
There are rectangular prisms everywhere around us! Commonly, they are in the form of cardboard boxes. Have students bring in a box (and/or provide boxes) for students to use in this assignment. Boxes can be any size, from candy boxes to jewelry boxes to granola bar boxes (or other food packaging), to shoe boxes, to mailing boxes.

Have students work individually or in pairs to find the volume of their box. They will need rulers to measure (specify if they should use inches or centimeters or something else). Have students label the length of each side on the box and then show their work to find the volume. They can make a poster for this if you'd like.

There may be interesting discussion possibilities if two or more boxes have the same volume but different dimensions, or if some boxes have one or two dimensions that are the same but other dimensions are different. Allow students some time to compare their boxes and volumes and share their findings.

Volume of the classroom
If your classroom is a rectangular prism then you can find the volume of it! Also find the area and perimeter of the floor and/or walls! This may take some creative thinking to find the height of the ceiling, but it is a good challenge for your students.

GENERAL CLASSROOM IMPLEMENTATION RESOURCES:

- Weekly Khan Academy quick planning guide: Use this template to plan your week using Khan Academy.
- Using Khan Academy in the classroom: Learn teaching techniques and strategies to support your students and save time with Khan Academy.
- Differentiation strategies for the classroom: Discover strategies to support the learning of all students.