

Volume of Rectangular Prisms with Holes



Grade Range: Middle School

Lesson Time: 40 minutes

Key Terms

Composite solid
Dimensions
Rainbow cubes
Rectangular prisms
Volume

Materials and Resources

Isometric dot paper
Images of buildings with holes in their designs
Model of a rectangular prism with a hole in the middle
zView

Activity Overview

La Grande Arche de la Défense near Paris, the Mirador apartment complex in Madrid, the Pentagon, the new Apple campus, and the Sheraton Huzhou Hot Spring Resort in China are a few examples of buildings designed with holes in the middle. The creativity of humans has allowed us to create wonders beyond simple geometric shapes. This ingenuity is possible because engineers, architects, and designers know how to use math to create these beautiful and amazing artistic structures. Students will learn to determine the volume of rectangular prisms with holes in the middle.

Essential Questions

1. How can subtraction assist in finding the volume of rectangular prisms with holes in them?
2. How can addition assist in finding the volume of rectangular prisms with holes in them?

Objectives

- Determine the volume of rectangular prisms with holes in the middle using subtraction
- Determine the volume of rectangular prisms with holes in the middle by adding the volumes of the prisms that compose the composite solid

Introduction

Prior to beginning this activity, students should understand the term *composite solid*, and be able to solve for the volume of composite solids by breaking them up into rectangular prisms. Optionally, have students complete *Volume of Rectangular Prisms: Using the Standard Algorithm (Fractions and Decimals)* and *Volume of Composite Solids: Using Rainbow Cubes* in Euclid's Shapes.

To begin the activity, connect to the students' background knowledge regarding rectangular prisms by asking: "What is a composite solid?" Show students photos or videos of buildings designed to have a hole in the middle, such as La Grande Arche de la Défense near Paris, the Mirador apartment complex in Madrid, the Pentagon, the new Apple campus, and

the Sheraton Huzhou Hot Spring Resort in China. Next, show them a rectangular prism with a hole cut out. Then ask: “How could you solve for the volume of a rectangular prism with a hole cut out?” Show students the *Volume of Rectangular Prisms with Holes Demo* using zView. Instruct students to discuss the following question with a partner: “Why do both methods work to solve the volume of the composite solid?” Explain that students will apply their skills in calculating the volume of rectangular prisms to composite solids with holes in them.

zSpace Activity

Activity Questions Provided in Euclid’s Shapes

Answers may vary. Sample answers are provided below.

- Assume each rainbow cube is 1 meter by 1 meter by 1 meter. Solve for the volume of this figure by first finding the volumes of the complete rectangular prism and the hole. Explain how you solved for your answer. Hint: You will subtract the volume of the hole from the complete rectangular prism’s volume.

240 cubic meters. The volume of the complete rectangular prism is 256 cubic meters. I found that volume by solving $8\text{ m} \times 8\text{ m} \times 4\text{ m}$. The volume of the hole is 16 cubic meters. I found its volume by solving $2\text{ m} \times 2\text{ m} \times 4\text{ m}$. Then I subtracted $256 - 16$ to find the volume of this figure.
- Assume each rainbow cube is 1 meter by 1 meter by 1 meter. Solve for the volume of this figure by dissecting the figure into the four rectangular prisms that compose the solid. Use the Ungroup function to break apart this figure, and use the Group function to rebuild the rainbow cubes into four smaller rectangular prisms. Take a photo. Explain how finding the volume of each rectangular prism allowed you to find the volume of the entire figure.

Photo that includes four rectangular prisms. [Two of the four rectangular prisms should have dimensions of $8\text{ m} \times 3\text{ m} \times 4\text{ m}$, each with a volume of 96 cubic meters. The other two rectangular prisms should be $2\text{ m} \times 3\text{ m} \times 4\text{ m}$, each with a volume of 24 cubic meters.] I added up the volume of the four rectangular prisms: $96 + 96 + 24 + 24 = 240$ cubic meters, which is the volume of this figure.
- Assume each rainbow cube is 1.5 meters by 1.5 meters by 1.5 meters. Solve for the volume of this figure by first finding the volumes of the complete rectangular prism and the hole. Show your answer in both fraction and decimal forms. Explain how you solved for your answer. Hint: You will subtract the volume of the hole from the complete rectangular prism’s volume.

121.5 cubic meters. The volume of the complete rectangular prism is 162 cubic meters. I found the volume by solving $6\text{ m} \times 6\text{ m} \times 4.5\text{ m}$. The volume of the hole was 40.5 cubic meters. I found its volume by solving $3\text{ m} \times 3\text{ m} \times 4.5\text{ m}$. Then I subtracted $162 - 40.5$ to find the volume of this figure.
- Assume each rainbow cube is 1.5 meters by 1.5 meters by 1.5 meters. Solve for the volume of this figure by dissecting the figure into the four rectangular prisms that compose the solid. Use the Ungroup function to break apart this figure, and use the Group function to rebuild the rainbow cubes into four smaller rectangular prisms. Take a photo. Explain how finding the volume of each rectangular prism allowed you to find the volume of the entire figure.

Photo that includes four rectangular prisms. [Two of the four rectangular prisms should have dimensions of $6\text{ m} \times 1.5\text{ m} \times 4.5\text{ m}$, each with a volume of 40.5 cubic meters. The other two rectangular prisms should be $3\text{ m} \times 1.5\text{ m} \times 4.5\text{ m}$, each with a volume of 20.25 cubic meters.] I added up the volume of the four rectangular prisms: $40.5 + 40.5 + 20.25 + 20.25 = 121.5$ cubic meters, which is the volume of this figure.

Closing

After students complete the activity, lead a discussion on what the class discovered about the different ways to solve for the volume of a composite solid with a hole in the middle.

Differentiation

- Group students heterogeneously to allow students with a strong command of the English language to assist in reading or interpreting questions
- Provide paper copies of diagrams for students to use as a reference
- Provide the unit cubes for students to use as hands-on models as they work through the problems
- Provide a handout with a list of vocabulary terms and definitions that will appear in the activity
- Allow students to provide answers that are handwritten, typed, or verbal
- Use text-to-speech if needed
- Enrichment: Students could research other man-made structures that have holes in their design and determine their volumes using the dimensions

Resources

<https://www.khanacademy.org/math/cc-fifth-grade-math/cc-5th-measurement-topic/cc-5th-volume/v/volume-of-a-rectangular-prism-or-box-examples>