Volume of a Rectangular Prism

Strand: Measurement and Geometry

Topic   Developing and using the formula for determining the volume of a rectangular prism.

Primary SOL   5.8 The student will

        a) solve practical problems that involve perimeter, area, and volume in standard units of measure.

Related SOL: 5.8b

Materials

- Transparent rectangular prisms (can be constructed using transparent plastic sheets)
- 1-inch or 1-centimeter cubes
- Different sizes of rectangular prisms (i.e., cereal boxes, tissue boxes, gift boxes)
- Poster paper or other large paper for an anchor chart
- Finding the Volume activity sheet (attached)

Vocabulary

capacity, cubic units, dimensions, height, length, rectangular prism, rectangular solid, three-dimensional, volume, width

Student/Teacher Actions: What should students be doing? What should teachers be doing?

1. Discuss the meaning of volume: the measure of the capacity of three-dimensional figures in cubic units. Listen for student words that convey this idea. Ask for examples of when one might need to know the volume of something. After the discussion, ask students to compare area and volume to allow them to continue to use the vocabulary of measurement.

2. Have several real-life objects (not pictures) that are shaped like a rectangular prism (e.g., tissue box, gift box, cardboard box, cereal box) in front of the room.
   a. Ask students to look closely at the shapes and sizes of your rectangular prisms. Have the students discuss what the prisms have in common.
   b. Allow students to individually write down what common characteristics they can identify about the prism. Listen for shape-related characteristics/terms, such as six sides, eight corners or vertices, sides or faces are rectangles, three-dimensional, can be used to hold something, etc. Record students' ideas on the board. If students did not use the terms *volume*, *solid*, *three-dimensional*, *length*, *width*, *height*, *rectangular prism*, and *rectangular solid*, be sure to include those in the list.

3. Place students into groups of three. Give each group the same-sized rectangular prism and some cubes. Ask students to estimate how many cubes it will take to fill the prism. Encourage students to find an organized way to fill the rectangular prism so that no empty space is left. Let students share their strategies, and listen for ideas, such as cover the

bottom first and then make layers until the prism is full. Instruct the students to make the bottom layer and figure out how many cubes it took. First, ask students to share the number of cubes and collect all answers. Then, discuss how many cubes it took to make the bottom layer and have students share how they determined how many cubes were used. Many students will say counting, but listen for ideas such as figuring the number of cubes along the length and the width and multiplying.

4. Ask students to make the second layer of cubes and figure out how many are in the rectangular prism now. Relate this to the height of the cubes.

5. Continue filling each layer until the prism is completely full. Ask the students to figure out how many cubes it took to fill the rectangular prism, explaining that they are finding the *volume* of the rectangular prism. Next, ask students to share the volumes they found and to explain how they got those answers. Record the information in words on the board, saving the symbols for later. Have students find the total number of cubes. Compare the total with their estimates.

6. Ask students whether their strategies for finding the total number of cubes it took to fill the rectangular prism would work for any rectangular prism. Hold up one of the smaller real-world rectangular solids and tell students to work individually to use words and pictures to write a *rule* for finding the volume. Give students time and walk around the room to note the ideas students are using in their writing. Let students know that the class will come back to this later in the lesson for students to polish or revise their rules.

7. Draw a rectangular prism on the board, showing the different layers of cubes and the amount in each layer. You can also take a photograph for use in class.
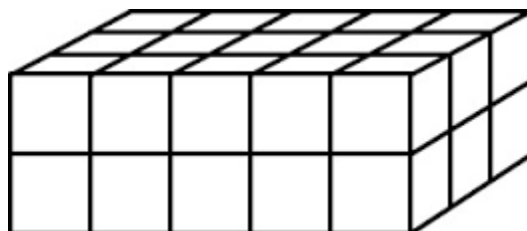
   a. Ask students to show how many cubes are in the length, width, and height. Show students how to use a ruler to show these same dimensions. Note that the unit on the ruler should correspond to the unit of the cubes that were used. Label the dimensions on the drawing or picture. Lead students in a discussion to refine their definition of volume: the measure of three-dimensional figures and measures the capacity in cubic units. Make the connections to using cubic units when measuring volume.

   b. Give the students a few minutes to review their original volume rules to make any changes they would like to make. Walk around the room again to identify several students you want to share their ideas. Look for examples of students adding the total number of cubes in each layer, as well as students multiplying the number cubes in each layer by the number of layers. Others may have realized the number of cubes is the height times the length times the width. Have the students you identified share their ideas. Write these on the board in words, then symbols. This is the time to emphasize that the volume is always

given in terms of cubic units based on the units of the cube used to fill the rectangular solid.

  c. Let students know that mathematicians also have rules that they call *formulas*, and they use particular mathematical symbols to convey the idea in an efficient way. Have the class help you create an anchor chart to display the definition of volume and a description in words of how to find the volume. Next, work with the class to label the dimensions of the rectangular solid and help the class translate from the word description to the formula length x width x height = Volume and, symbolically, *l* x *w* x *h*= *V*. Record the formula in words and symbols on the anchor chart.

8. Give each group of students a different type of rectangular solid, some cubes, and a ruler. Instruct them to work together to answer the following and record their answers in their notebooks.

  a. Estimate the volume.

  b. Use the formula to calculate the volume and show your work with a pictorial representation of the rectangular solid. Record your answer with appropriate units.

  c. Use the cubes to fill the rectangular solid so that you can compare the answer to what you found when you calculated the volume using the formula.

9. Have students complete the Finding the Volume activity sheet. Students may use a calculator to find the volume (optional).

Assessment

- **Questions**
  - What is volume? Explain to someone who does not know.
  - Why is volume measured in cubic units?
  - How do we measure the volume of a really large object that is a rectangular prism?
  - What situations in real life might require knowing the volume?

- **Journal/writing prompts**
  - Explain the differences and similarities between area and volume and how to calculate the measures of each.
  - Describe a practical example of when you would need to find the volume of a rectangular solid or prism.

- **Other Assessments**
  - Write a story problem that requires finding volume.
  - If the volume of a gift box is 240 cubic centimeters, the length is 10 centimeters, and the width is 8 centimeters, what is the height? Explain how you found the answer.

Extensions and Connections

- The dimensions of a gift box are 9.25 centimeters by 6.5 centimeters by 10 centimeters. What is the volume of the gift box? Show your work with pictures and numbers.

- How could two rectangular solids have different dimensions but the same volume?

- A candy maker is trying to decide what size boxes to order to pack his candies for shipping. The shipping box, which the boxes of candy are placed in for shipment, is 18 inches tall, 12 inches wide, and 24 inches long. The candies are about 1 inch by 1 inch by 1 inch and he packs them in layers with the same number of candies in each layer. The candy boxes must all be the same size. What are the best dimensions for the candy maker to request for the candy boxes? Show your work and justify your answer.

- Place students in groups of two or three, and have each group use 72 cubes to build and find the volume of as many rectangular prisms as they can, using all 72 cubes. Show your work with pictures and numbers. Then answer the following questions: What did you notice about the rectangular prisms? What did you notice about the dimensions? What did you notice about the volume? What conclusions can you draw based on what you noticed?

- Display three rectangular prisms of various sizes, and ask students to predict which will have the greatest volume and the reason for their prediction. Fill each with rice to determine which has the greatest volume based on the number of cups of rice each holds.

- Karen has a box that holds 24 cubic centimeters. What could the height, width and length be?

- The carpenter is building a storage box for a customer's garage. The customer needs the box to hold 160 square feet. Based on the corner where he wants to place the box, it needs to be 5 feet wide and 12 feet long. How tall does the storage box need to be? Show your work with pictures and numbers.

Strategies for Differentiation

- Begin with prisms that have dimensions that are whole numbers less than 10. Give plenty of experience finding the volume of different prisms using cubes and the formula together.

- Have precut rectangles and squares for students to build several sizes of rectangular solids and then find the volume of those solids.

- Relate the classroom to a rectangular prism, with base of the prism representing the classroom floor.

- Have students find the volume of another prism. Some students may need to estimate and/or continue to use cubes.

- Give students 36 cubes and have them find all of its dimensions. Ask students to assign a real-life situation where they would use each dimension.

Note: The following pages are intended for classroom use for students as a visual aid to learning.

Finding the Volume

Directions: Estimate and find the volume for each problem below. Show your work.

1. Mr. Grant bought a box with the dimensions of: height 5 inches, width 5 inches, length 10 inches. What is the volume of the box?
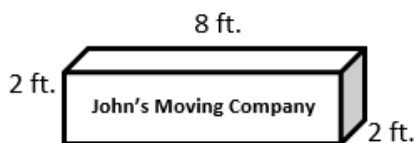
Estimate: _____   Volume: _____

2. Cori has a box filled with candy bars. The dimensions of all sides of the box are equal. If the length of the box is 30 centimeters, what is the volume of the box?

Estimate: _____   Volume: _____

3. Julie has an aquarium with the dimensions of 6 meters long, 5 meters wide, and 3 meters high. Pam has an aquarium with the dimensions of 7 meters long, 3 meters wide, and 5 meters high. Which aquarium has the greatest volume?

Estimate: _____   Volume: _____

4.

Estimate: _____

Volume: _____

5.

12 in.

10 in.

10 in.

Estimate: _____

Volume: _____

6.

2 in.

2 in.

2 in.

Estimate: _____

Volume: _____