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Reproducible Tool Set 175

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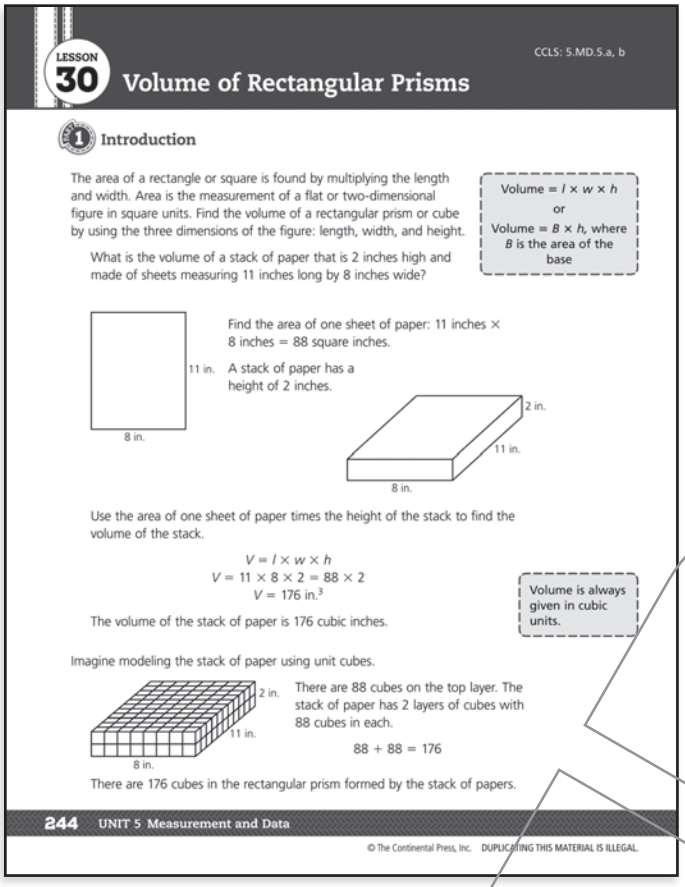

LESSON 30

CCLS: 5.MD.5.a, b

Volume of Rectangular Prisms

1 Introduction

The area of a rectangle or square is found by multiplying the length and width. Area is the measurement of a flat or two-dimensional figure in square units. Find the volume of a rectangular prism or cube by using the three dimensions of the figure: length, width, and height.

Volume = $l \times w \times h$ or Volume = $B \times h$, where B is the area of the base

What is the volume of a stack of paper that is 2 inches high and made of sheets measuring 11 inches long by 8 inches wide?

11 in. 8 in.

Find the area of one sheet of paper: 11 inches × 8 inches = 88 square inches.

A stack of paper has a height of 2 inches.

2 in. 11 in. 8 in.

Use the area of one sheet of paper times the height of the stack to find the volume of the stack.

$V = l \times w \times h$
$V = 11 \times 8 \times 2 = 88 \times 2$
$V = 176$ in.^{3}

Volume is always given in cubic units.

The volume of the stack of paper is 176 cubic inches.

Imagine modeling the stack of paper using unit cubes.

2 in. 11 in. 8 in.

There are 88 cubes on the top layer. The stack of paper has 2 layers of cubes with 88 cubes in each.

88 + 88 = 176

There are 176 cubes in the rectangular prism formed by the stack of papers.

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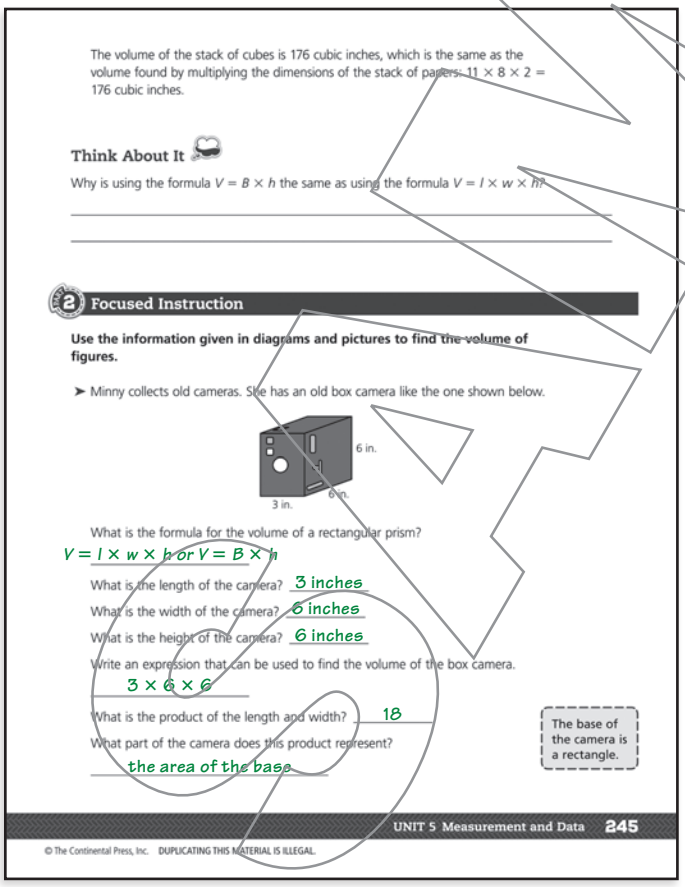

The volume of the stack of cubes is 176 cubic inches, which is the same as the volume found by multiplying the dimensions of the stack of papers: 11 × 8 × 2 = 176 cubic inches.

Think About It

Why is using the formula $V = B \times h$ the same as using the formula $V = l \times w \times h$?

2 Focused Instruction

Use the information given in diagrams and pictures to find the volume of figures.

➤ Minny collects old cameras. She has an old box camera like the one shown below.

6 in. 3 in. 6 in.

What is the formula for the volume of a rectangular prism?
$V = l \times w \times h$ or $V = B \times h$

What is the length of the camera? 3 inches
What is the width of the camera? 6 inches
What is the height of the camera? 6 inches

Write an expression that can be used to find the volume of the box camera.
3 × 6 × 6

What is the product of the length and width? 18

What part of the camera does this product represent?
the area of the base

The base of the camera is a rectangle.

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Objective

To find the volume of rectangular prisms by using the volume formula

PART 1 Introduction

Review the formula for area of a rectangle with students. Show them, using the diagram on the student book page, how area is related to volume. Demonstrate how the volume formula is a short cut to counting unit cubes.

Think About It

Students should recognize that the area formula for a rectangle ($A = l \times w$) is actually part of the volume formula for a rectangular prism ($V = l \times w \times h$). So if the area of the base is already known, it can be substituted for $l \times w$ in the formula.

Common Core Learning Standards

5.MD.5 Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.

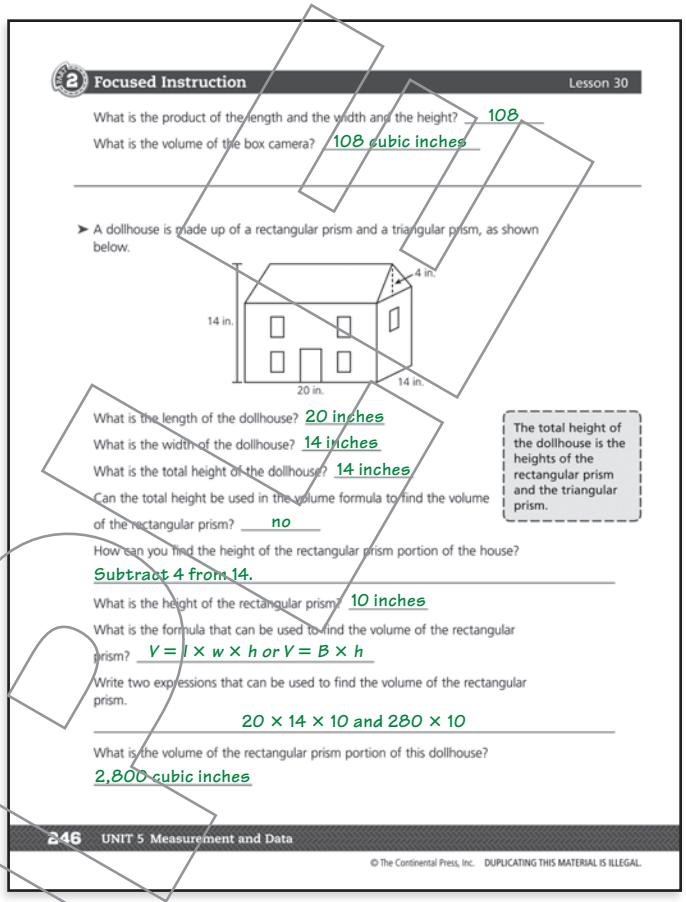
a. Find the volume of a right rectangular prism with whole-number side lengths by packing it with unit cubes, and show that the volume is the same as would be found by multiplying the edge lengths, equivalently by multiplying the height by the area of the base. Represent threefold whole-number products as volumes, e.g., to represent the associative property of multiplication.

b. Apply the formulas $V = l \times w \times h$ and $V = B \times h$ for rectangular prisms to find volumes of right rectangular prisms with whole-number edge lengths in the context of solving real world and mathematical problems.

Focused Instruction

Students will work through two problems to find the volumes of rectangular prisms. They will identify the length, width, and height for each prism and use the volume formula. In the second problem, they must be aware of the part of the diagram for which they are finding the volume. They need to calculate the height of the prism using the given measurements on the diagram.

Conclude the Focused Instruction section by having students answer two questions about volume.



Focused Instruction Lesson 30

What is the product of the length and the width and the height? 108

What is the volume of the box camera? 108 cubic inches

➤ A dollhouse is made up of a rectangular prism and a triangular prism, as shown below.

What is the length of the dollhouse? 20 inches

What is the width of the dollhouse? 14 inches

What is the total height of the dollhouse? 14 inches

Can the total height be used in the volume formula to find the volume of the rectangular prism? no

The total height of the dollhouse is the heights of the rectangular prism and the triangular prism.

How can you find the height of the rectangular prism portion of the house?

Subtract 4 from 14.

What is the height of the rectangular prism? 10 inches

What is the formula that can be used to find the volume of the rectangular prism? $V = l \times w \times h$ or $V = B \times h$

Write two expressions that can be used to find the volume of the rectangular prism.

$20 \times 14 \times 10$ and 280×10

What is the volume of the rectangular prism portion of this dollhouse?

2,800 cubic inches

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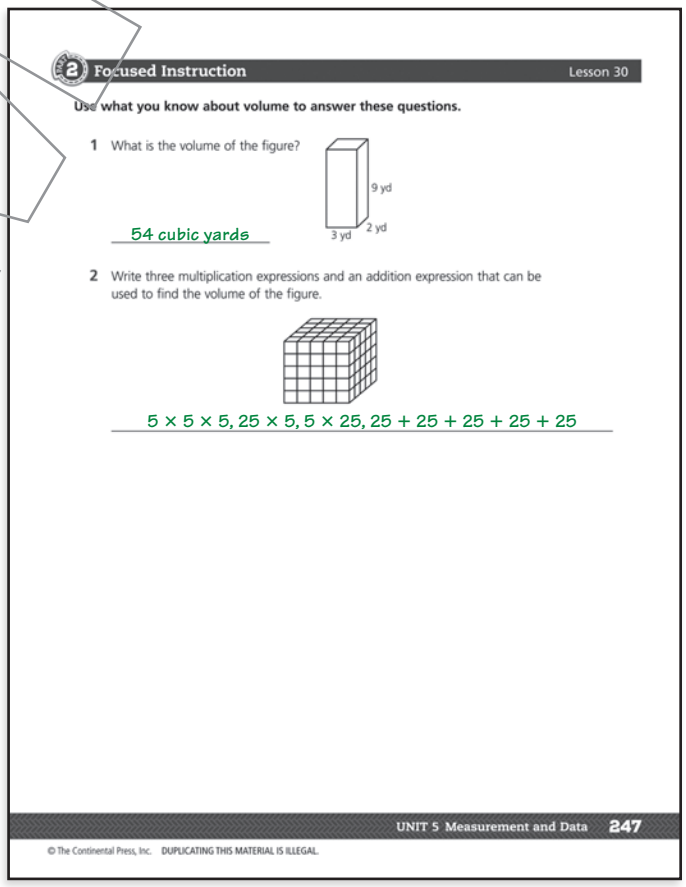

Focused Instruction Lesson 30

Use what you know about volume to answer these questions.

1 What is the volume of the figure?

54 cubic yards

2 Write three multiplication expressions and an addition expression that can be used to find the volume of the figure.

$5 \times 5 \times 5$, 25×5, 5×25, $25 + 25 + 25 + 25 + 25$

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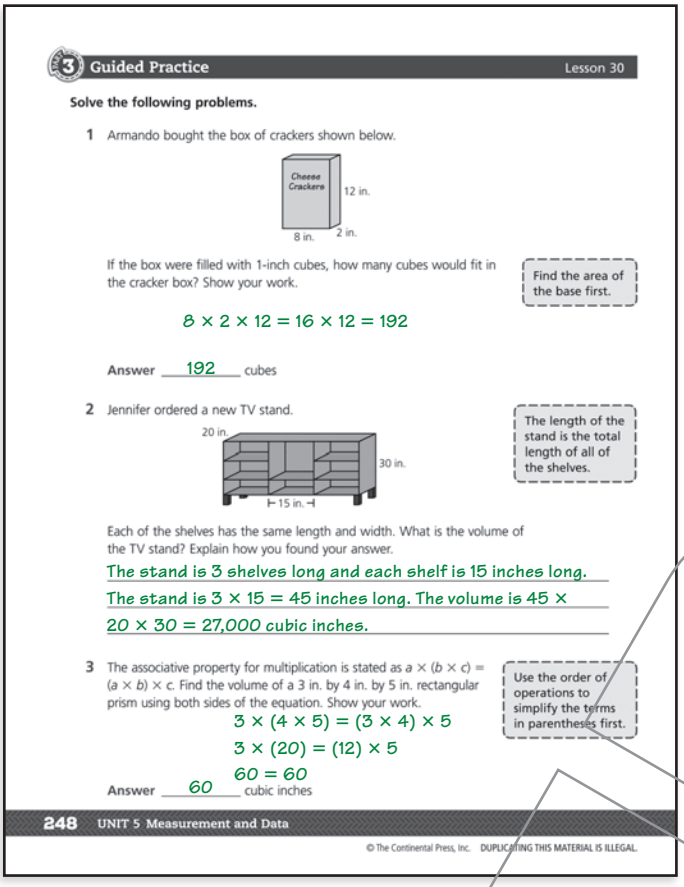
Connections to Standards for Mathematical Practice

- Make sense of problems and persevere in solving them.
- Model with mathematics.
- Use appropriate tools strategically.
- Attend to precision.
- Look for and make use of structure.



3 Guided Practice Lesson 30

Solve the following problems.

1 Armando bought the box of crackers shown below.

If the box were filled with 1-inch cubes, how many cubes would fit in the cracker box? Show your work.

Find the area of the base first.

$8 \times 2 \times 12 = 16 \times 12 = 192$

Answer 192 cubes

2 Jennifer ordered a new TV stand.

The length of the stand is the total length of all of the shelves.

Each of the shelves has the same length and width. What is the volume of the TV stand? Explain how you found your answer.

The stand is 3 shelves long and each shelf is 15 inches long. The stand is $3 \times 15 = 45$ inches long. The volume is $45 \times 20 \times 30 = 27{,}000$ cubic inches.

3 The associative property for multiplication is stated as $a \times (b \times c) = (a \times b) \times c$. Find the volume of a 3 in. by 4 in. by 5 in. rectangular prism using both sides of the equation. Show your work.

Use the order of operations to simplify the terms in parentheses first.

$3 \times (4 \times 5) = (3 \times 4) \times 5$

$3 \times (20) = (12) \times 5$

$60 = 60$

Answer 60 cubic inches

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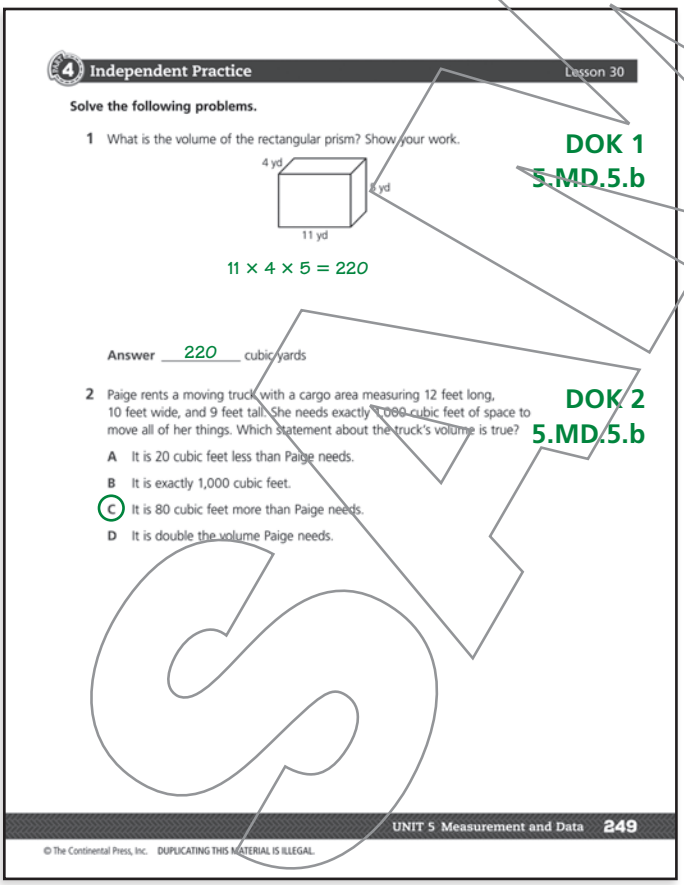

4 Independent Practice Lesson 30

Solve the following problems.

1 What is the volume of the rectangular prism? Show your work.

DOK 1
5.MD.5.b

$11 \times 4 \times 5 = 220$

Answer 220 cubic yards

2 Paige rents a moving truck with a cargo area measuring 12 feet long, 10 feet wide, and 9 feet tall. She needs exactly 1,000 cubic feet of space to move all of her things. Which statement about the truck's volume is true?

DOK 2
5.MD.5.b

A It is 20 cubic feet less than Paige needs.

B It is exactly 1,000 cubic feet.

(C) It is 80 cubic feet more than Paige needs.

D It is double the volume Paige needs.

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PART 3 Guided Practice

Students should complete the Guided Practice section on their own. Offer assistance as needed, pointing out the reminder and hint boxes along the right side of the page.

PART 4 Independent Practice Answer Rationales

1 To find the volume of a rectangular prism, multiply the length, width, and height: $V = 11 \times 4 \times 5$; $V = 11 \times 20 = 220$ yd^3.

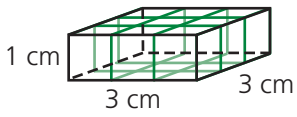
2 The volume of the cargo area is $l \times w \times h$ or $12 \times 10 \times 9 = 120 \times 9 = 1{,}080$ cubic feet. Paige needs 1,000 ft^3, so the actual cargo area volume is $1{,}080 - 1{,}000 = 80$ ft^3 greater than she needs. Choice C is correct.

3 PART A Find the volume of each crate using the formula, $V = l \times w \times h$. Crate 1 has a volume of $20 \times 20 \times 20 = 8{,}000$ in.^{3}. Crate 2 has a volume of $50 \times 10 \times 10 = 5{,}000$ in.^{3}, so crate 1 has a greater volume.

PART B To find the number of baseballs that will fit in crate 1, divide the volume of the crate by the volume of each baseball box. Crate 1 can fit $8{,}000 \div 100 = 80$ baseballs. The cost per ball is \$0.50, so it will cost $80 \times \$0.50 = \$40.00$ to ship the baseballs.

4 Find the volume of each DVD set first using the formula $V = l \times w \times h$. The volume of the family set is $16 \times 4 \times 9 = 64 \times 9 = 576$ in.^{3}. The volume of the sci-fi set is $6 \times 9 \times 14 = 54 \times 14 = 756$ in.^{3}. The volume of the sci-fi set is greater by $756 - 576 = 180$ in.^{3}.

5 The sugar cubes are the same height as the box, 1 cm. The length of the box is equal to 3 sugar cubes. The width of the box is equal to 3 sugar cubes. If the box is filled with 1-cm sugar cubes, it will look like the box shown below.

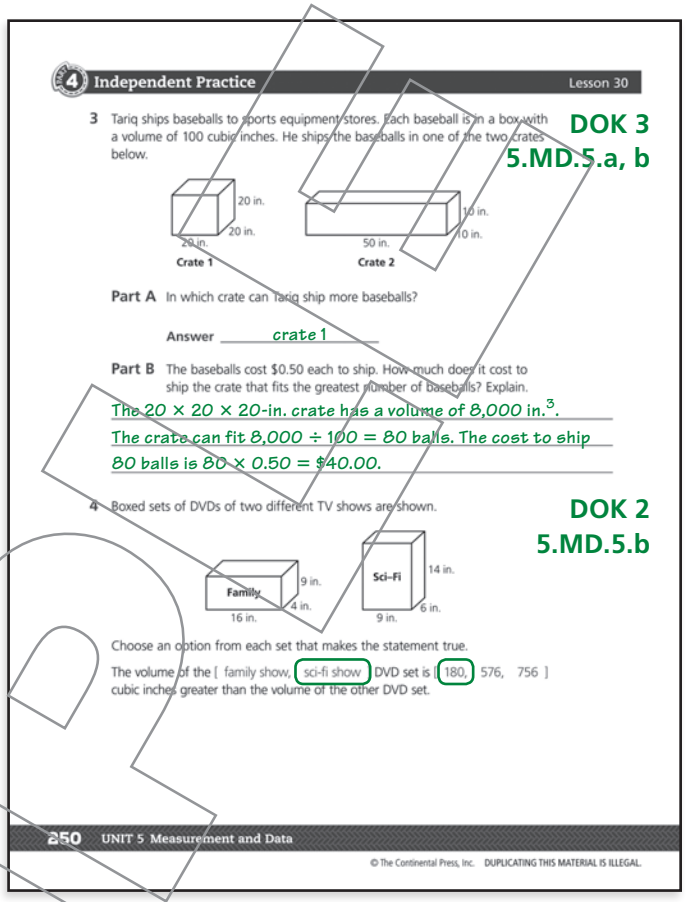


6 PART A Divide the length, width, and height into single units to draw the model of 1-ft cubes. The model should have a length of 6 unit cubes, a width of 3 unit cubes, and a height of 3 unit cubes.

PART B To find the volume in yards, convert the dimensions to yards. Since 1 yard equals 3 feet, divide the number of feet by 3 to find the number of yards per dimension: $6 \text{ ft} \div 3 = 2$ yd; $3 \text{ ft} \div 3 = 1$ yd; $3 \text{ ft} \div 3 = 1$ yd. The dimensions are 2 yards by 1 yard by 1 yard. Use the volume formula $V = l \times w \times h$ to find the volume of the ant tank: $2 \times 1 \times 1 = 2$ cubic yards.

Extension Activity

For homework, have students find the volume of a rectangular prism in their home. They will need to measure the length, width, and height in an appropriate measurement unit and calculate the volume. They should record what the object is and its dimensions. Then they should draw a model of the object using unit cubes.



4 Independent Practice — Lesson 30

3 Tariq ships baseballs to sports equipment stores. Each baseball is in a box with a volume of 100 cubic inches. He ships the baseballs in one of the two crates below. DOK 3 5.MD.5.a, b

Part A In which crate can Tariq ship more baseballs?

Answer crate 1

Part B The baseballs cost \$0.50 each to ship. How much does it cost to ship the crate that fits the greatest number of baseballs? Explain.

The 20 × 20 × 20-in. crate has a volume of 8,000 in.^{3}. The crate can fit 8,000 ÷ 100 = 80 balls. The cost to ship 80 balls is 80 × 0.50 = \$40.00.

4 Boxed sets of DVDs of two different TV shows are shown. DOK 2 5.MD.5.b

Choose an option from each set that makes the statement true.

The volume of the [family show, sci-fi show] DVD set is [180, 576, 756] cubic inches greater than the volume of the other DVD set.

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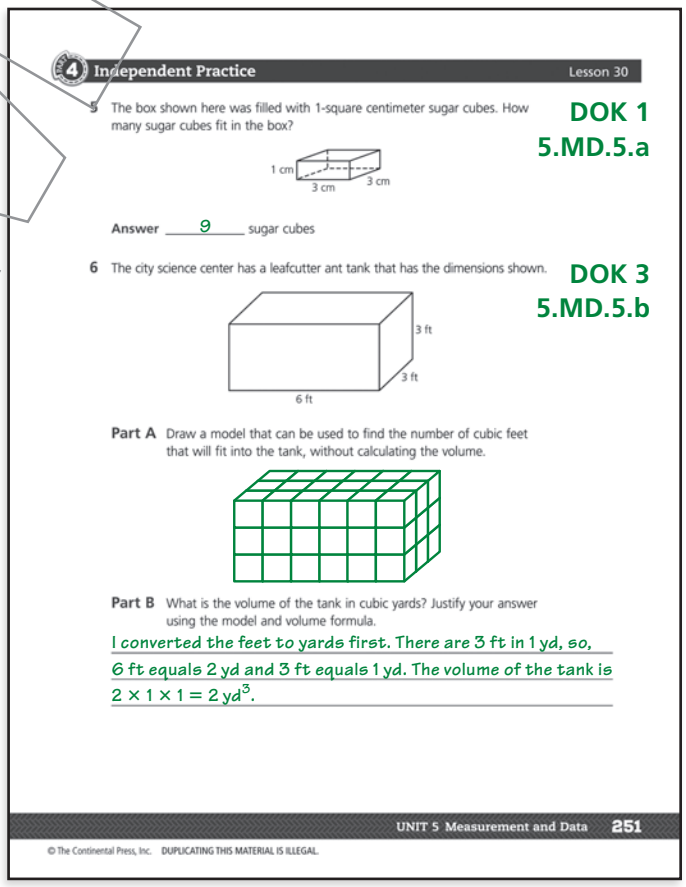

4 Independent Practice — Lesson 30

5 The box shown here was filled with 1-square centimeter sugar cubes. How many sugar cubes fit in the box? DOK 1 5.MD.5.a

Answer 9 sugar cubes

6 The city science center has a leafcutter ant tank that has the dimensions shown. DOK 3 5.MD.5.b

Part A Draw a model that can be used to find the number of cubic feet that will fit into the tank, without calculating the volume.

Part B What is the volume of the tank in cubic yards? Justify your answer using the model and volume formula.

I converted the feet to yards first. There are 3 ft in 1 yd, so, 6 ft equals 2 yd and 3 ft equals 1 yd. The volume of the tank is 2 × 1 × 1 = 2 yd^3.

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