Inspect
CCR Performance Tasks

Math Grade 7: Use Surface Area and Volume to Solve a Real-World Problem

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Inspect offers the following assessment products:

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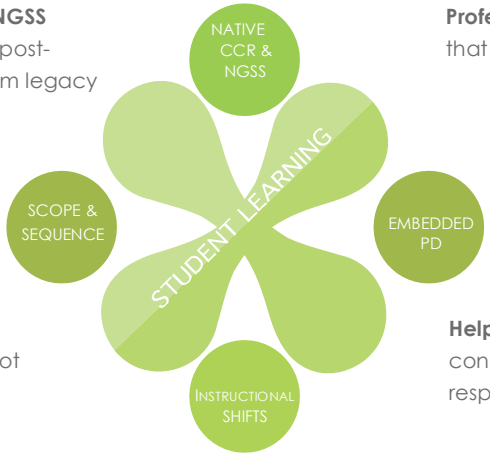
Observational Tasks for English/Language Arts and Math Grades K - 1	▪ Developmentally appropriate for individual students and small groups

Inspect Assessment Content is available through a variety of assessment administration and data analysis platforms.

Inspect assessment content offers these benefits:

Native college- and career-ready and NGSS content prepares students to meet their post-secondary goals. Content re-aligned from legacy standards cannot do this.



Professional development embedded within content that

- shows the relationship between specific skills and higher-order thinking
- includes authentic, permissioned texts of appropriate complexity
- and documents student progress using DOK and learning progressions

Content that addresses your scope and sequence so that your assessments do not waste valuable instruction time

Help for teachers addressing the instructional shifts with content that elicits evidence of learning from each response

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CCR Performance Tasks

Math Grade 7: Use Surface Area and Volume to Solve a Real-World Problem

Student Test Booklet

Name:

_____

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Math Grade 7: Use Surface Area and Volume to Solve a Real-World Problem

Student Rubric

This problem is meant to test if you can:
- Develop and use a strategy to solve a problem.
- Persevere to completely solve the problem even if your first solution attempt does not work.
- Recognize the relationships between volume, surface area, and the dimensions of a three-dimensional object.
- Compute the surface area and volume of a three-dimensional object.

Your teacher will rate your answer as a level 4, 3, 2, 1, or 0. The descriptions below explain the types of answers expected at each level.

Level 4:
Your answer is correct and complete.
Your answer includes:
- A drawing that shows the dimensions for an aquarium that meets specific volume and surface area criteria;
- Complete calculations that correctly show the volume and surface area of the aquarium that you created;
- A description of how you approached the problem and found a solution.

Level 3:
Your answer is correct but one or two of your explanations are incomplete, or you have made minor calculation mistakes.
Your answer includes:
- A drawing that shows dimensions for an aquarium that meets specific volume and surface area criteria;
- Calculations that show the volume and surface area of the aquarium that you created, but the calculations may contain minor errors or be incomplete;
- A description of how you approached the problem and found a solution, but your description may be incomplete.

Level 2:
You have answered one part correctly but your explanations are missing or weak.
Your answer includes:
- A drawing that shows dimensions for an aquarium that meet only one of the two criteria for volume and surface area;
- Calculations that attempt to show the volume and surface area of the aquarium that you created, but the calculations may contain errors;
- An incomplete description of how you approached the problem and found a solution.

Level 1:
Your answers are incorrect.
Your answer includes:
- A drawing that shows dimensions for an aquarium that satisfies neither of the two criteria for volume or surface area;
- Calculations that attempt to show the volume and surface area of the aquarium that you created, with major errors;
- Vague or missing work or description of your method or strategy for finding a shape that meets both criteria.

Level 0:
Your answer is not related to the question, the teacher cannot understand your answer, or you do not write anything.

Math Grade 7: Use Surface Area and Volume to Solve a Real-World Problem

Complete all the tasks in the test booklet.

1 **To complete this task, you need the following materials:**

- **A set of 80 unit cubes**

Your school is planning to put an aquarium with 30 fish in the main lobby. To accommodate this number of fish, the aquarium should hold between 50 and 60 cubic feet of water. To help reduce costs, the surface area of the aquarium should be no more than 80 square feet. (Note that aquariums have open tops, so do not include the area of the top in your calculation of the surface area.)

A. Let each unit cube represent one cubic foot of water. Use the unit cubes to make a model of an aquarium that meets the volume and surface area criteria. It may take you more than one try to come up with a model that meets both criteria. Use the space below to make calculations and to keep track of the shapes you try, even if you first come up with an aquarium shape that doesn't meet both criteria.

Go On

B. Draw a picture of your aquarium, labeling the length, width, and height. Give the volume and surface area of the aquarium. Show your work.

C. Describe the strategy you used to find a shape that meets the volume and surface area criteria.

STOP

CCR Performance Tasks

Math Grade 7: Use Surface Area and Volume to Solve a Real-World Problem

Teacher Guide

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About the Teacher Guide

This document contains support materials for “Math Grade 7: Use Surface Area and Volume to Solve a Real-World Problem.”

This includes:

(a) The task
(b) The standards and depth of knowledge level of the task
(c) The scoring rubric
(d) Discussion questions
(e) Extension activities

These specifications have been included to help you connect the task to the Common Core content standards and the standards for mathematical practice. The rubric is designed to help you look for the development of mathematical practices in student work. It is also here to help you look for consistencies in student content errors that can help guide intervention and re-teach strategies.

Test Definition File

Item #	Correct Answer	Practice Standard	Content Standards
1	See Scoring Rubric	Mathematical Practice 1	7.G.6

SBACC Claims	PARCC Sub-Claims
1 and 2	B and D

Performance Task

To complete this task, students will need the following materials:

- **A set of 80 unit cubes**

Your school is planning to put an aquarium with 30 fish in the main lobby. To accommodate this number of fish, the aquarium should hold between 50 and 60 cubic feet of water. To help reduce costs, the surface area of the aquarium should be no more than 80 square feet. (Note that aquariums have open tops, so do not include the area of the top in your calculation of the surface area.)

A. Let each unit cube represent one cubic foot of water. Use the unit cubes to make a model of an aquarium that meets the volume and surface area criteria. It may take you more than one try to come up with a model that meets both criteria. Use the space below to make calculations and to keep track of the shapes you try, even if you first come up with an aquarium shape that doesn't meet both criteria.

B. Draw a picture of your aquarium, labeling the length, width, and height. Give the volume and surface area of the aquarium. Show your work.

C. Describe the strategy you used to find a shape that meets the volume and surface area criteria.

Standards Alignment

Practice Standards

MP1 > DOK 3

Make sense of problems and persevere in solving them. -- Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, “Does this make sense?” They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

Content Standards

7.G.6

Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

SBAC Claims

Mathematics Claim #1:
Concepts and Procedures. Students can explain and apply mathematical concepts and interpret and carry out mathematical procedures with precision and fluency.

Mathematics Claim #2:
Problem Solving. Students can solve a range of complex, well-posed problems in pure and applied mathematics, making productive use of knowledge and problem solving strategies.

PARCC Sub-Claims

Sub Claim B:
Additional and Supporting Content with Connections to Practices. The student solves problems involving the Additional and Supporting Content for her grade/course with connections to the Standards for Mathematical Practice.

Sub Claim D:
Highlighted Practice MP.4 with Connections to Content: modeling/application. The student solves real-world problems with a degree of difficulty appropriate to the grade/course by applying knowledge and skills articulated in the standards for the current grade/course (or, for more complex problems, knowledge and skills articulated in the standards for previous grades/courses), engaging particularly in the Modeling practice, and where helpful making sense of problems and persevering to solve them (MP.1), reasoning abstractly and quantitatively (MP.2), using appropriate tools strategically (MP.5), looking for and making use of structure (MP.7), and/or looking for and expressing regularity in repeated reasoning (MP.8).

Scoring Rubric

4 Point Response:

The response demonstrates a high level of understanding. A level 4 response is characterized by:

- A strong ability to develop and implement a strategy to solve a problem;
- Perseverance when solving a real-world problem for which the answer is not immediately obvious;
- Recognition of the relationships between surface area, volume, and the dimensions of a three-dimensional object;
- The ability to compute the surface area and volume of a three-dimensional object.

A level 4 response should include:

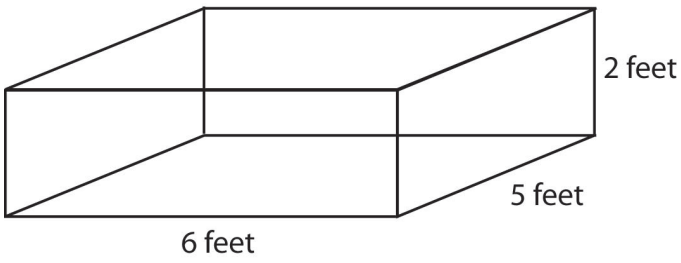
- Dimensions for a right rectangular prism with a volume between 50 and 60 cubic feet and a surface area less than 80 square feet;
- Complete work or a description of a strategy that shows how the final and intermediate (if any) shapes were determined;
- Complete calculations that correctly show the volume and surface area of the prism that was created.

Note that part A should show calculations using different dimensions the student tried or a table of dimensions used that resulted in a surface area or volume that was too large. This part is not scored but may provide insight into the strategy used and thus contribute to part C.

A sample level 4 response follows.

Sample answer 1:
Part B:

The volume of my shape is length × width × height = 6 × 5 × 2 = 60 units, which represents 60 cubic feet. The area of the bottom is 6 × 5 = 30 square feet, the areas of the front and back are each 6 × 2 = 12 square feet, and the area of each side is 5 × 2 = 10 square feet; so, the total surface area (not including the top) is 30 + (2 × 12) + (2 × 10) = 74 square feet.

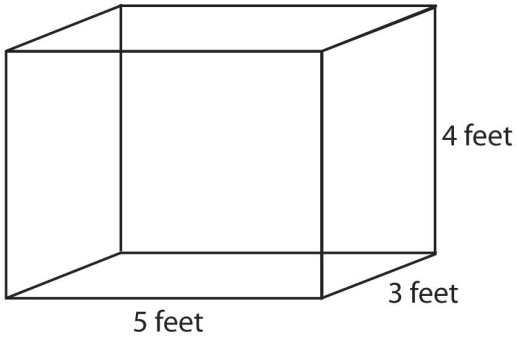


Part C:

"Since I know that 6 × 5 is 30, and 30 is half of 60, which is the maximum volume, I took 30 cubes and used them to make a base of 6 by 5 cubes. Then I put one more layer of cubes to make a total of 60 cubes. Then I calculated the surface area and found it was less than 80 square feet. An aquarium that is 6 feet long, 5 feet wide, and 2 feet tall has the right surface area and volume."

Sample answer 2:
Part B:

Volume = 4 × 5 × 3 = 60 cubic feet.
Surface area (no top) = (3 × 5) × 2(3 × 4) + 2(4 × 5) = 15 + 24 + 40 = 79 square feet.



Part C:
"I started by making a layer of cubes that was 10 cubes long and 3 cubes wide. I then added another layer on top to make a shape that was 10 × 3 × 2. This shape meets the volume criteria of 60. Then I drew a net and found that the surface area was (3 × 10) + 2(3 × 2) + 2(3 × 10) = 30 + 12 + 60 = 112, which is greater than 80. So I went back to make another shape by making the length only 5 cubes. That left enough cubes to make the height 4. So my second shape was 5 cubes long, 3 cubes wide, and 4 cubes tall. The volume of this shape is 5 × 3 × 4 = 60 units. Since each unit is a cubic foot, my aquarium is 60 cubic feet. I drew another net and found that the surface area of this shape is (3 × 5) + 2(3 × 4) + 2(4 × 5) = 15 + 24 + 40 = 79 square feet, which meets the surface area criteria of being less than 80 square feet. So, an aquarium that is 5 feet long, 3 feet wide, and 4 feet tall meets the criteria for both volume and surface area."

Note there are many sets of dimensions that meet the volume and surface area criteria.

3 Point Response:
The response demonstrates a strong understanding, but the work is incomplete or contains minor errors. A level 3 response is characterized by:

- Perseverance when solving a real-world problem for which the answer is not immediately obvious, even if a complete solution is not developed;
- Recognition of the relationships between surface area, volume, and the dimensions of a three-dimensional object;
- The ability to compute the surface area and volume of a three-dimensional object, but the work contains minor errors.

2 Point Response:
The response demonstrates a basic but incomplete understanding. A level 2 response is characterized by:

- Waning perseverance when solving a real-world problem for which the answer is not immediately obvious, although a partial solution is attempted;
- Incomplete recognition of the relationships between surface area, volume, and the dimensions of a three-dimensional object, and the relationships may not be stated explicitly;
- The ability to compute the surface area or volume of a three-dimensional object, but the work may contain minor errors.

1 Point Response:
The response demonstrates minimal understanding. A level 1 response is characterized by:

- Lack of perseverance when solving a real-world problem for which the answer is not immediately obvious and an incorrect solution is presented;
- Incorrect recognition and statement of the relationships between surface area, volume, and the dimensions of a three-dimensional object;
- A weak ability to compute the surface area and volume of a three-dimensional object, with several minor or major errors.

0 Point Response:
There is no response, or the response is off topic.

Discussion Questions

Use the following questions to support students struggling to access the problem:

1. A box is 3 feet long, 2 feet wide, and 1 foot deep. How many 1’ × 1’ × 1’ cubes fit inside this box?

Possible response: *Six cubes.*

2. A box is 3 feet long, 2 feet wide, and 5 feet deep. How many 1’ × 1’ × 1’ cubes fit inside this box?

Possible response: *Thirty cubes. There are 3 × 2 = 6 cubes in each layer, and there are 5 layers.*

3. What are volume and surface area?

Possible response: *Volume is the amount of space inside a three-dimensional object. It is measured in cubic units, because it is equal to the number of cubes needed to fill the inside. Surface area is the amount of area on all of the faces.*

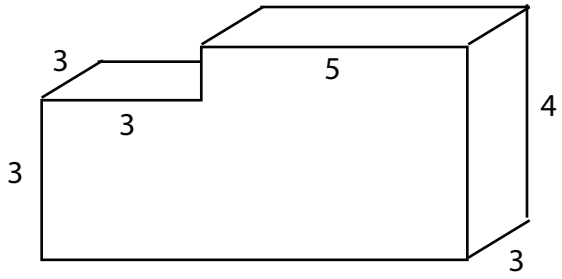
4. How can you compute volume and surface area?

Possible response: *The volume can be found by counting the number of cubes that fit within the shape. This is why volume is measured in cubic units. The volume of a prism can be calculated by finding length × width × height. The surface area can be found by adding up the areas of all of the faces. For a prism, the surface area is 2 × (lw + lh + wh).*

Extension Activities

1. Find the surface area and volume of composite shapes.

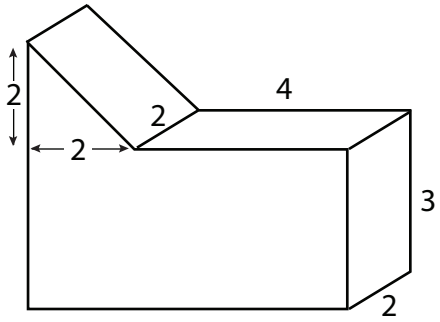
a. What are the volume and surface area of the simple, composite shape shown below? It is made of a 3 × 3 × 3 cube attached to a 3 × 4 × 5 prism.



Sample response: The volume of the shape is equal to the volume of the cube plus the volume of the prism: (3 × 3 × 3) + (3 × 4 × 5) = 27 + 60 = 87 cubic units. The surface area is the sum of the areas of all the faces.

Front and back faces = 2[(3 × 3) +(5 × 4)] = 2[29] = 58
Bottom face = 3 × (3+5)= 24
Large left side face = 3 × 3 = 9, and small left side face = 1 × 3 = 3
Right side face = 3 × 4 = 12
Small top face = 3 × 3 = 9, and large top face = 5 × 3 = 15
Total surface area = 58 + 24 + 9 + 3 + 12 + 9 + 15 = 130 square units

b. What are the volume and surface area of the more complex, composite shape shown below? It is made of a rectangular prism with a triangular prism sitting on top of one side of the rectangular prism.



Sample response: The volume is the sum of the volumes of the two shapes:

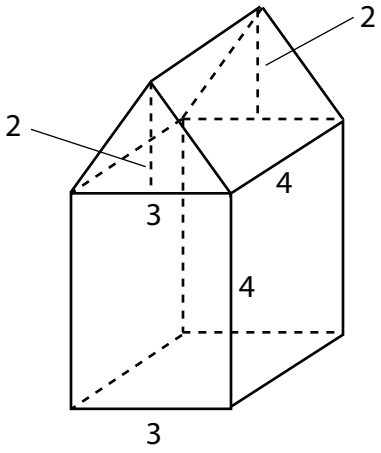
Volume of triangular prism = $(\frac{1}{2} \times 2 \times 2 \times 2) = 4$

Volume of rectangular prism = $(2 \times 3 \times (2 + 4) = 36$

Total volume = 4 + 36 = 40 cubic units

2. Design more complex shapes that meet certain volume and surface area criteria.
   When building a house in a cold climate, you want to minimize the surface area of the house to minimize loss of heat. But a house usually is made of composite shapes, not just a single cube or rectangular prism like your aquarium. Using the unit blocks, design a composite shape for a house that has a volume between 50 and 60 cubic units, and a surface area of no more than 100 square units. Use any shapes you want, but you have to show that the volume and surface area criteria are met by your shape. Depending on which shapes you choose, you may have to estimate the volume while building your shapes from the unit block, and then use area and volume formulas to get accurate values for the volume and surface area.

Sample response: There are many possible shape combinations that meet these criteria.
For example:



The volume of this shape is $(3 \times 4 \times 4) + (\frac{1}{2} \times 2 \times 3 \times 4) = 48 + 12 = 60$ cubic units.

The surface area of this shape is the sum of:
2 square sides of the shape: $2(4 \times 4) = 32$
2 rectangular sides and bottom of the shape: $3(3 \times 4) = 36$

Front and back triangular faces: $2(\frac{1}{2} \times 2 \times 3) = 6$

2 rectangular top faces (one side is the hypotenuse of the half-triangular face. Students can estimate this length or measure it with a ruler if the drawing is to scale. The actual length is 2.5 units.):$2(4 \times 2.5) = 20$

Thus the total surface area is $32 + 36 + 6 + 20 = 94$ square units.