



**pennsylvania**  
DEPARTMENT OF EDUCATION

# The Pennsylvania System of School Assessment

## Mathematics Item and Scoring Sampler



**2021\***  
**Grade 5**

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\* This is a revised version of the 2017 Item and Scoring Sampler.

## Mathematics Test Directions

On the following pages are the mathematics questions.

- You may not use a calculator for question 1. You may use a calculator for all other questions on this test.

### Directions for Multiple-Choice Questions

Some questions will ask you to select an answer from among four choices.

For the multiple-choice questions:

- First solve the problem on scratch paper.
- Choose the correct answer and record your choice in the answer booklet.
- If none of the choices matches your answer, go back and check your work for possible errors.
- Only one of the answers provided is the correct response.

### Directions for Open-Ended Questions

Some questions will require you to write your response.

For the open-ended questions:

- These questions have more than one part. Be sure to read the directions carefully.
- You cannot receive the highest score for an open-ended question without completing all tasks in the question. For example, if the question asks you to show your work or explain your reasoning, be sure to show your work or explain your reasoning in the space provided.
- If the question does **not** ask you to show your work or explain your reasoning, you may use the space provided, but only those parts of your response that the question specifically asks for will be scored.
- Write your response in the appropriate location within the response box in the answer booklet. Some answers may require graphing, plotting, labeling, drawing, or shading. If you use scratch paper, be sure to transfer your final response and any needed work or reasoning to the answer booklet.

## General Description of Scoring Guidelines for Mathematics Open-Ended Questions

### 4— The response demonstrates a *thorough* understanding of the mathematical concepts and procedures required by the task.

The response provides correct answer(s) with clear and complete mathematical procedures shown and a correct explanation, as required by the task. Response may contain a minor “blemish” or omission in work or explanation that does not detract from demonstrating a *thorough* understanding.

### 3— The response demonstrates a *general* understanding of the mathematical concepts and procedures required by the task.

The response and explanation (as required by the task) are mostly complete and correct. The response may have minor errors or omissions that do not detract from demonstrating a *general* understanding.

### 2— The response demonstrates a *partial* understanding of the mathematical concepts and procedures required by the task.

The response is somewhat correct with *partial* understanding of the required mathematical concepts and/or procedures demonstrated and/or explained. The response may contain some work that is incomplete or unclear.

### 1— The response demonstrates a *minimal* understanding of the mathematical concepts and procedures required by the task.

### 0— The response has no correct answer and *insufficient* evidence to demonstrate any understanding of the mathematical concepts and procedures required by the task for that grade level.

Response may show only information copied from the question.

Special Categories within zero reported separately:

BLK (blank).....Is blank, is entirely erased, or gives a written refusal to respond

OT.....Is off-task

LOE.....Is in a language other than English

IL.....Is illegible

# Grade 5 Formula Sheet

Formulas and conversions that you may need on this test are found below.  
You may refer back to this page at any time during the mathematics test.

2021  
Grade 5

## Standard Conversions

1 mile (mi) = 1,760 yards (yd)  
1 mile = 5,280 feet (ft)  
1 yard (yd) = 3 feet (ft)  
1 foot = 12 inches (in.)

1 ton (T) = 2,000 pounds (lb)  
1 pound = 16 ounces (oz.)

1 gallon (gal) = 4 quarts (qt)  
1 quart = 2 pints (pt)  
1 pint = 2 cups (c)  
1 cup = 8 fluid ounces (fl oz.)

## Metric Conversions

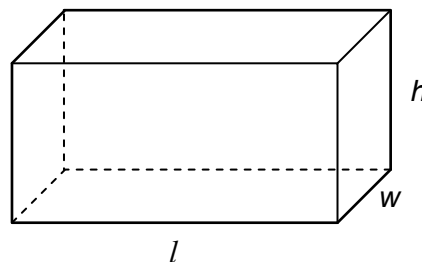
1 kilometer (km) = 1,000 meters (m)  
1 meter = 100 centimeters (cm)  
1 centimeter = 10 millimeters (mm)

1 kilogram (kg) = 1,000 grams (g)  
1 liter (L) = 1,000 milliliters (mL)

## Time Conversions

1 century = 10 decades  
1 decade = 10 years (yr)  
1 year (yr) = 12 months (mo)  
1 year = 52 weeks (wk)  
1 year = 365 days  
1 week = 7 days  
1 day = 24 hours (hr)  
1 hour = 60 minutes (min)  
1 minute = 60 seconds (sec)

## Rectangular Prism



Volume = length  $\times$  width  $\times$  height  
 $V = l \times w \times h$

Volume = area of the base  $\times$  height  
 $V = B \times h$

Volume = area of the base  $\times$  width  
 $V = B \times w$

Volume = area of the base  $\times$  length  
 $V = B \times l$

Question 1 in this sampler is to be solved without the use of a calculator.

## MULTIPLE-CHOICE ITEMS

1. Multiply:  $640 \times 390$

- A. 249,600
- B. 293,600
- C. 540,000
- D. 768,000

Item Information	
Alignment	A-T.2.1.1
Answer Key	A
Depth of Knowledge	1
p-value A	69% (correct answer)
p-value B	9%
p-value C	7%
p-value D	15%
Option Annotations	<p>A. Correct: determines the partial products by multiplying 640 by 90 and 640 by 300 and then adds the partial products (<math>57,600 + 192,000</math>) OR multiplies 64 by 39 and then multiplies the product (2,496) by 100 [most likely by appending two 0s to 2,496]</p> <p>B. adds the regrouped digit to the next digit before multiplying (e.g., when multiplying 640 by 90, correctly regroups the 3 from 36 to the hundreds column but adds it to the 6 before multiplying by 9 instead of multiplying 6 by 9 and then adding the regrouped 3)</p> <p>C. multiplies <math>6 \times 3 = 18</math> and <math>4 \times 9 = 36</math>, adds <math>18 + 36</math>, and then appends enough zeros to get the correct number of places</p> <p>D. aligns the partial products incorrectly by including an extra 0 in the first partial product (576,000)</p>

A calculator is permitted for use in solving questions 2–17 in this sampler.

2. Darren is told that the weight of an old coin is 37.2 grams. However, when he weighs the coin he finds that the digit in the hundredths place has a value that is  $\frac{1}{10}$  of the value of the digit in the tenths place. Which expression, in expanded form, shows the weight, in grams, Darren finds?
- A.  $30 + 2 + 0.2$   
 B.  $30 + 7 + 0.2 + 0.01$   
 C.  $30 + 7 + 0.2 + 0.02$   
 D.  $30 + 7 + 0.2 + 0.10$

Item Information	
Alignment	A-T.1.1.1 A-T.1.1.3
Answer Key	C
Depth of Knowledge	2
p-value A	11%
p-value B	33%
p-value C	34% (correct answer)
p-value D	22%
Option Annotations	<p>A. places a 2 in the ones place instead of the 7 and omits the hundredths place value</p> <p>B. places a 1 in the hundredths place because of the <math>\frac{1}{10}</math></p> <p>C. Correct: identifies the digit in the tenths place as 2, determines <math>\frac{1}{10}</math> of this value as 0.02, writes the original number in expanded form, and adds the 0.02 to the expanded form</p> <p>D. uses a 10 as the basis for the hundredths place because of the <math>\frac{1}{10}</math></p>

3. The table below shows four mineral samples and the mass of each sample.

Mineral Masses

Mineral	Mass (grams)
albite	3.012
graphite	3.07
magnetite	3.061
quartz	3.05

Which number sentence correctly compares the masses, in grams, of two of the mineral samples?

- A.  $3.05 < 3.061$
- B.  $3.05 < 3.012$
- C.  $3.012 > 3.07$
- D.  $3.012 > 3.061$

Item Information	
Alignment	A-T.1.1.4
Answer Key	A
Depth of Knowledge	1
p-value A	63% (correct answer)
p-value B	10%
p-value C	13%
p-value D	14%
Option Annotations	<p>A. Correct: identifies that the leftmost place value with a difference is the hundredths place and compares <math>5 &lt; 6</math> OR recognizes that the whole parts of the masses are all the same, rewrites 3.05 as 3.050, and compares the numbers after the decimal as <math>50 &lt; 61</math></p> <p>B. thinks a “three-digit” number must be less than a “four-digit” number</p> <p>C. compares <math>12 &gt; 7</math> without considering place value after the decimal</p> <p>D. compares only the last digits (thousandths place)</p>

4. Jake measured the amount of salt in two liters of seawater. His results are listed below.

first liter: 33.165 grams

second liter: 35.787 grams

He rounds both values to the nearest hundredth and adds them. What is the sum of the rounded amounts of salt Jake found in the seawater?

- A. 68.95 grams
- B. 68.952 grams
- C. 68.957 grams
- D. 68.96 grams

Item Information	
Alignment	A-T.1.1.5 A-T.2.1.3
Answer Key	D
Depth of Knowledge	2
p-value A	13%
p-value B	26%
p-value C	7%
p-value D	54% (correct answer)
Option Annotations	<p>A. adds the values first and then rounds the sum OR rounds the first value down using “if 5 or less, then round down” as the rounding rule instead of “if 5 or greater, then round up”</p> <p>B. does not round OR thinks the hundredths place is the third digit after the decimal point</p> <p>C. rounds only the first value to the hundredth</p> <p>D. Correct: rounds the first value up to 33.17 based on the 5 in the thousandths place, rounds the second value up to 35.79 based on the 7 in the thousandths place, and then adds these rounded amounts</p>



5. Students are weighing two types of rubber balls during science class.

- Each yellow rubber ball weighs 1.28 pounds.
- Each red rubber ball weighs 0.96 pound.

What is the total weight of 25 yellow rubber balls and 50 red rubber balls?

- A. 56 pounds
- B. 80 pounds
- C. 88 pounds
- D. 168 pounds

Item Information	
Alignment	A-T.2
Answer Key	B
Depth of Knowledge	2
p-value A	8%
p-value B	74% (correct answer)
p-value C	10%
p-value D	8%
Option Annotations	<p>A. determines the weight using 25 of each type of ball:  <math>25 \times 1.28 + 25 \times 0.96</math></p> <p>B. Correct: determines the combined weight of all the yellow balls (<math>25 \times 1.28</math>), the combined weight of all the red balls (<math>50 \times 0.96</math>), and then adds the combined weights (<math>32 + 48</math>)</p> <p>C. reverses the weight and number of each type of ball:  <math>25 \times 0.96 + 50 \times 1.28</math></p> <p>D. multiplies the total number of balls by the total weight:  <math>(25 + 50) \times (1.28 + 0.96)</math></p>

6. A gardening shop receives a shipment of 12 crates of plants. Each crate contains 18 plants. A worker displays all the plants on 24 shelves with the same number of plants on each shelf. How many plants are displayed on each shelf?
- A. 6
  - B. 9
  - C. 16
  - D. 36

Item Information	
Alignment	A-T.2.1.2 A-T.2.1.1
Answer Key	B
Depth of Knowledge	2
p-value A	15%
p-value B	60% (correct answer)
p-value C	9%
p-value D	16%
Option Annotations	<p>A. calculates <math>12 + 18 - 24</math></p> <p>B. Correct: determines the total number of plants by multiplying the number of crates by the number of plants in each crate (<math>12 \times 18</math>) and then divides this value by the number of shelves (<math>216 \div 24</math>)</p> <p>C. calculates <math>12 \times 24 \div 18</math></p> <p>D. calculates <math>18 \times 24 \div 12</math></p>

7. An after-school program has 24 sports video games students can play after they finish their homework. There are three types of sports games.

football:  $\frac{1}{6}$  of  $\frac{1}{2}$  of the video games

basketball:  $\frac{1}{4}$  of  $\frac{2}{3}$  of the video games

soccer: the remaining video games

How many video games are soccer games?

- A. 2
- B. 4
- C. 18
- D. 20

Item Information	
Alignment	A-F.2.1
Answer Key	C
Depth of Knowledge	2
p-value A	17%
p-value B	30%
p-value C	38% (correct answer)
p-value D	15%
Option Annotations	<p>A. determines the number of video games that are football games</p> <p>B. determines the number of video games that are basketball games</p> <p>C. Correct: determines the number of football video games by multiplying <math>\frac{1}{6}</math> by <math>\frac{1}{2}</math> by 24, the number of basketball video games by multiplying <math>\frac{1}{4}</math> by <math>\frac{2}{3}</math> by 24, and the number of soccer video games by subtracting the first two products from 24 (<math>24 - 2 - 4</math>)</p> <p>D. adds all the numbers in the numerators and denominators of the fractions in the stem</p>

8. A space heater warms the temperature of a room by  $\frac{2}{3}$  of a degree Fahrenheit each minute. By how many degrees Fahrenheit will the space heater warm the room in  $6\frac{1}{2}$  minutes?
- A.  $4\frac{1}{3}$
- B.  $5\frac{5}{6}$
- C.  $7\frac{1}{6}$
- D.  $9\frac{3}{4}$

Item Information	
Alignment	A-F.2.1.2
Answer Key	A
Depth of Knowledge	2
p-value A	56% (correct answer)
p-value B	13%
p-value C	21%
p-value D	10%
Option Annotations	<p>A. Correct: multiplies <math>\frac{2}{3}</math> by <math>6\frac{1}{2}</math> by converting <math>6\frac{1}{2}</math> to <math>\frac{13}{2}</math>, multiplying the numerators and the denominators, <math>\frac{2 \times 13}{3 \times 2}</math>, and then converting back to a mixed number OR multiplies <math>\frac{2}{3}</math> by 6 and <math>\frac{2}{3}</math> by <math>\frac{1}{2}</math> and then adds the partial products <math>\left(4 + \frac{1}{3}\right)</math></p> <p>B. subtracts <math>\frac{2}{3}</math> from <math>6\frac{1}{2}</math></p> <p>C. adds <math>6\frac{1}{2}</math> and <math>\frac{2}{3}</math></p> <p>D. divides <math>6\frac{1}{2}</math> by <math>\frac{2}{3}</math></p>

9. Sophie had 60 flashlights for sale at her store. She sold  $\frac{4}{5}$  of the flashlights. Which statement about the number of flashlights sold must be true?
- A. Sophie sold 48 flashlights because  $60 \times \frac{4}{5} = 48$ .
- B. Sophie sold 75 flashlights because  $60 \div \frac{4}{5} = 75$ .
- C. Sophie sold 52 flashlights because  $\frac{4}{5} = 0.8$  and  $60 - 8 = 52$ .
- D. Sophie sold 40 flashlights because both the numerator and the denominator of  $\frac{4}{5}$  are factors of both 40 and 60.

Item Information	
Alignment	A-F.2.1.3
Answer Key	A
Depth of Knowledge	2
p-value A	48% (correct answer)
p-value B	19%
p-value C	16%
p-value D	17%
Option Annotations	<p>A. Correct: interprets the phrase "<math>\frac{4}{5}</math> of the flashlights" as requiring multiplication</p> <p>B. uses division instead of multiplication</p> <p>C. correctly converts <math>\frac{4}{5}</math> to 0.8 but misapplies the 8 from 0.8</p> <p>D. misapplies the numbers from the fraction</p>

10. Emma and Bella collect bugs for a science project.

- On Monday, Emma collects 15 bugs, and Bella collects 3 times as many bugs as Emma collects.
- On Tuesday, Emma collects 6 bugs, and Bella collects 8 times as many bugs as Emma collects.

Which expression can be used to find the total number of bugs the girls collect on both days?

- A.  $(15 + 6) \times (3 + 8)$
- B.  $(15 + 3) \times (6 + 8)$
- C.  $[15 + (3 \times 15)] + [6 + (8 \times 6)]$
- D.  $[15 \times (3 + 15)] + [6 \times (8 + 6)]$

Item Information	
Alignment	B-O.1.1.1 B-O.1.1.2
Answer Key	C
Depth of Knowledge	2
p-value A	14%
p-value B	16%
p-value C	53% (correct answer)
p-value D	17%
Option Annotations	<p>A. uses 3 and 8 as the number of Bella's bugs instead of <math>3 \times 15</math> and <math>8 \times 6</math> and then finds the product of the numbers of bugs instead of the sum</p> <p>B. lists all the numbers and key words given in order of appearance in stem, using + for "and" and grouping symbols for each bulleted sentence, and then multiplies the groups</p> <p>C. Correct: uses <math>3 \times 15</math> to represent the number of bugs Bella collects on Monday and <math>15 + (3 \times 15)</math> to represent the total number of bugs Emma and Bella collect on Monday, uses <math>8 \times 6</math> to represent the number of bugs Bella collects on Tuesday and <math>6 + (8 \times 6)</math> to represent the total number of bugs Emma and Bella collect on Tuesday, and then adds these amounts together using brackets as grouping symbols around the expression for each day's total</p> <p>D. reverses the operations within brackets</p>

11. The number of marbles in a jar is 4 times the difference between 17 and 12. Which expression can be used to find the number of marbles in the jar?
- A.  $4 \times (17 - 12)$
  - B.  $(17 - 12) + 4$
  - C.  $4 \times 17 - 12$
  - D.  $17 \times 12 - 4$

Item Information	
Alignment	B-O.1.1.2
Answer Key	A
Depth of Knowledge	2
p-value A	72% (correct answer)
p-value B	10%
p-value C	11%
p-value D	7%
Option Annotations	<p>A. Correct: interprets “the difference between 17 and 12” as <math>17 - 12</math> and sets this expression inside grouping symbols since “4 times the difference” means finding the difference before multiplying by 4</p> <p>B. adds 4 to the difference instead of multiplying the difference by 4</p> <p>C. does not use grouping symbols to enforce finding the difference before multiplying by 4</p> <p>D. knows that 17 and 12 should be applied first, but uses multiplication as the first operation since it is mentioned first in the stem</p>

12. The numbers shown below are used at the beginning of two different patterns.

2, 6, \_\_, \_\_, \_\_, ...

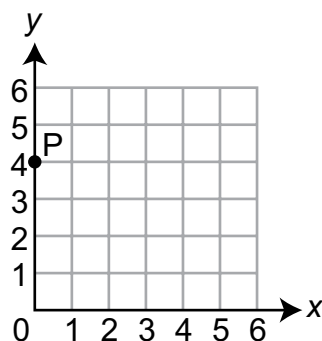
One pattern's rule is to add the same number each time. The other pattern's rule is to multiply by the same number each time. What is the **smallest** number greater than 6 that appears in both patterns?

- A. 10
- B. 12
- C. 16
- D. 18

Item Information	
Alignment	B-O.2.1
Answer Key	D
Depth of Knowledge	2
p-value A	24%
p-value B	31%
p-value C	8%
p-value D	37% (correct answer)
Option Annotations	<p>A. finds the next number in the “add 4” pattern</p> <p>B. incorrectly determines that an “add 4” pattern will always result in a multiple of 4; multiplies 6 by 2 instead of by 3 to get 12 (a multiple of 4)</p> <p>C. incorrectly determines that an “add 4” pattern will always result in a multiple of 4; thinks the multiplication pattern will always result in a 6 in the ones place; calculates the first multiple of 4 that ends in a 6</p> <p>D. Correct: solves <math>2 + \square = 6</math> to extend the first pattern using the rule “add 4,” solves <math>2 \times \square = 6</math> to extend the second pattern using the rule “multiply by 3,” and determines 18 as being the next number that appears in both patterns (2, 6, 10, 14, <u>18</u>, ... and 2, 6, <u>18</u>, ...)</p>



13. Point P is shown on the coordinate grid below.

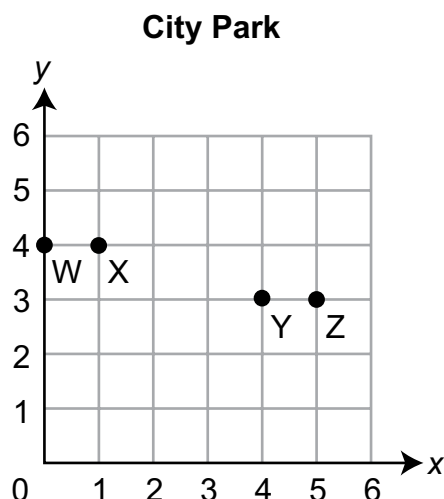


Which statement about point P is true?

- A. Point P is on the  $x$ -axis and has an  $x$ -coordinate of 0.
- B. Point P is on the  $x$ -axis and has a  $y$ -coordinate of 0.
- C. Point P is on the  $y$ -axis and has an  $x$ -coordinate of 0.
- D. Point P is on the  $y$ -axis and has a  $y$ -coordinate of 0.

Item Information	
Alignment	C-G.1.1.1
Answer Key	C
Depth of Knowledge	1
$p$ -value A	8%
$p$ -value B	6%
$p$ -value C	67% (correct answer)
$p$ -value D	19%
Option Annotations	<p>A. misidentifies the axis</p> <p>B. misidentifies both the axis and which coordinate should be 0</p> <p>C. Correct: recognizes the vertical axis as the <math>y</math>-axis and that points along this axis have an <math>x</math>-coordinate of 0 since the point is 0 units to the right of the axis OR recognizes the vertical axis as the <math>y</math>-axis and determines that the <math>x</math>-coordinate is 0 since the point is directly above the 0 on the <math>x</math>-axis</p> <p>D. misidentifies which coordinate should be 0</p>

14. Clayton mapped out the city park on the coordinate grid shown.

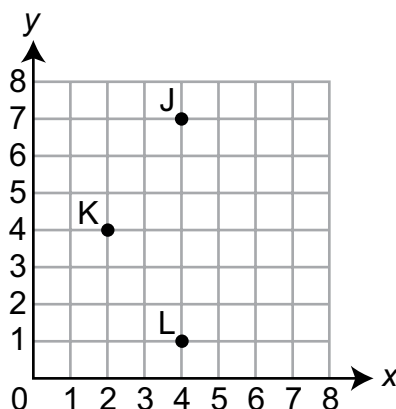


A drinking fountain is located at the point  $(1, 3)$ . A statue in the park is located 4 units away from the drinking fountain. Which point could be the location of the statue?

- A. point W
- B. point X
- C. point Y
- D. point Z

Item Information	
Alignment	C-G.1.1.2
Answer Key	D
Depth of Knowledge	2
p-value A	5%
p-value B	9%
p-value C	23%
p-value D	63% (correct answer)
Option Annotations	<p>A. identifies a point that is 4 units away from the x-axis instead of from <math>(1, 3)</math></p> <p>B. identifies a point with the same x-value as <math>(1, 3)</math> and is 4 units away from the x-axis instead of from <math>(1, 3)</math> OR identifies the point that is closest to <math>(1, 3)</math></p> <p>C. identifies a point with the same y-value as <math>(1, 3)</math> and is 4 units away from the y-axis instead of from <math>(1, 3)</math></p> <p>D. Correct: identifies the location of the drinking fountain at <math>(1, 3)</math> and then identifies the location of the statue by moving 4 units to the right of <math>(1, 3)</math></p>

15. Points J, K, and L are shown on the coordinate grid below.



Point M will be plotted at (6, 4). The four points form the vertices of a shape. Which statement describes the shape that is formed?

- A. The shape is a rhombus, but not a square.
- B. The shape is a square, but not a rectangle.
- C. The shape is a parallelogram, but not a rhombus.
- D. The shape is a parallelogram, but not a quadrilateral.

Item Information	
Alignment	C-G.2.1.1 C-G.1.1.2
Answer Key	A
Depth of Knowledge	2
p-value A	58% (correct answer)
p-value B	16%
p-value C	16%
p-value D	10%
Option Annotations	<p>A. Correct: identifies that the shape has all equal sides (is a rhombus) and no right angles (so is not a square)</p> <p>B. identifies that the shape has all equal sides (like a square) and no right angles (so is not a rectangle) but does not recognize that squares are rectangles and must have right angles (so the shape cannot be a square)</p> <p>C. identifies that the shape has parallel opposite sides (is a parallelogram) but does not recognize that the sides are all equal in length (so the shape is also a rhombus)</p> <p>D. identifies that the shape has parallel opposite sides (is a parallelogram) but does not recognize that parallelograms are quadrilaterals since they have exactly 4 sides (so the shape is also a quadrilateral)</p>

16. A rock weighs  $6\frac{1}{2}$  tons. How many pounds does the rock weigh?

- A. 12,000 pounds
- B. 13,000 pounds
- C. 192,000 pounds
- D. 208,000 pounds

Item Information	
Alignment	D-M.1.1.1
Answer Key	B
Depth of Knowledge	1
p-value A	24%
p-value B	67% (correct answer)
p-value C	5%
p-value D	4%
Option Annotations	<p>A. omits the <math>\frac{1}{2}</math> during the conversion and multiplies 6 by 2,000</p> <p>B. Correct: uses the conversion 1 ton = 2,000 pounds to multiply <math>6\frac{1}{2}</math> by 2,000</p> <p>C. omits the <math>\frac{1}{2}</math> during the conversion and multiplies 6 by <math>2,000 \times 16</math> (converts to ounces)</p> <p>D. multiplies <math>6\frac{1}{2}</math> by <math>2,000 \times 16</math> (converts to ounces)</p>

## OPEN-ENDED QUESTION

17. Luke works in the shipping department of a toy company. He sends toys in boxes that are each in the shape of a rectangular prism. The lengths, widths, and heights of all the boxes are whole numbers of inches.

Luke needs to find a box that has a total volume of 24 cubic inches.

- A. Find a possible combination of length, width, and height, all in whole numbers of inches, of a box Luke could use.

Luke is shipping another toy that has a volume of 34 cubic feet. The box he will use has a base of 15 square feet and a height of 3 feet. The rest of the box will be filled with packing material.

- B. What is the volume, in cubic feet, of the packing material Luke will need? Show or explain all your work.

Go to the next page to finish question 17.

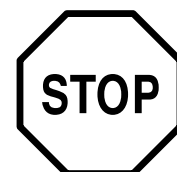


**17. Continued.** Please refer to the previous page for task explanation.

Luke has a toy, shaped like a rectangular prism, that needs to be sent in a box. The measurements of the toy are 8 inches long, 5 inches wide, and 6 inches high. To make sure there is enough room for the packing material, the measurements of the box need to be at least 1 inch greater than the length, width, and height of the toy. The box's volume must be less than 400 cubic inches.

- C.** Explain why there is only one possible combination of length, width, and height of the box.

**After you have checked your work, close your answer booklet and test booklet so your teacher will know you are finished.**



# Item-Specific Scoring Guideline

## #17 Item Information

<b>Alignment</b>	D-M.3	<b>Depth of Knowledge</b>	3	<b>Mean Score</b>	1.25
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### Assessment Anchor this item will be reported under:

M05.D-M.3—Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.

### Specific Anchor Descriptor addressed by this item:

M05.D-M.3.1 — Use, describe, and develop procedures to solve problems involving volume.

### Scoring Guide

Score	In this item, the student . . .
4	Demonstrates a thorough understanding of volume and how to relate volume to multiplication and to addition by correctly solving problems and clearly explaining procedures.
3	Demonstrates a general understanding of volume and how to relate volume to multiplication and to addition by correctly solving problems and clearly explaining procedures with only minor errors or omissions.
2	Demonstrates a partial understanding of volume and how to relate volume to multiplication and to addition by correctly performing a significant portion of the required task.
1	Demonstrates minimal understanding of volume and how to relate volume to multiplication and to addition.
0	The response has no correct answer and insufficient evidence to demonstrate any understanding of the mathematical concepts and procedures as required by the task. Response may show only information copied from the question.

### Top-Scoring Student Response and Training Notes

Score	Description
4	Student earns 4 points.
3	Student earns 3.0–3.5 points.
2	Student earns 2.0–2.5 points.
1	Student earns 0.5–1.5 points.  OR Student demonstrates minimal understanding of volume and how to relate volume to multiplication and to addition.
0	Response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.

## Top-Scoring Response

### Part A (1 point):

1 point for correct answer

What?	Why?
<p>Answers may vary. Accept any combination of 3 whole numbers that have a product of 24.</p> <p><b>Sample Response:</b> 2, 2, 6</p>	

### Part B (2 points):

1 point for correct answer

1 point for complete support

OR  $\frac{1}{2}$  point for correct but incomplete support

What?	Why?
11 (cubic feet)	<p><b>Sample Work:</b>  <math>15 \times 3 = 45</math>  <math>45 - 34 = 11</math></p> <p><b>OR</b></p> <p><b>Sample Explanation:</b>            To find the volume of the packing material Luke will need, I need to find the volume of the box. Using the formula <math>V = B \times h</math>, the volume of the box is <math>15 \times 3 = 45</math> cubic feet. Since the toy has a volume of 34 cubic feet, the volume of the packing material Luke will need is <math>45 - 34 = 11</math> cubic feet.</p>



**Part C (1 point):**

1 point for complete explanation

OR  $\frac{1}{2}$  point for correct but incomplete explanation

What?	Why?
	<p><b>Sample Explanation:</b></p> <p>Since the measurements of the box need to be at least 1 inch greater than the length, width, and height of the package, the box must be at least 9 inches long, 6 inches wide, and 7 inches high. This is a volume of 378 cubic inches, which is less than 400 cubic inches. By adding 1 more inch to the length, the new volume would be 420 cubic inches, which is too big. By adding 1 more inch to the width, the new volume would be 441 cubic inches, which is too big. By adding 1 more inch to the height, the new volume would be 432 cubic inches, which is also too big. So there is only one possible combination of length, width, and height for the box.</p>

## STUDENT RESPONSE

## Response Score: 4 points

17. Luke works in the shipping department of a toy company. He sends toys in boxes that are each in the shape of a rectangular prism. The lengths, widths, and heights of all the boxes are whole numbers of inches.

Luke needs to find a box that has a total volume of 24 cubic inches.

- A. Find a possible combination of length, width, and height, all in whole numbers of inches, of a box Luke could use.

length = 2 inches   height = 4 inches  
width = 3 inches

The student has given a correct answer (length = 2 inches, height = 4 inches, width = 3 inches). These three whole numbers (2, 4, and 3) have a product of 24. [1 point]

Luke is shipping another toy that has a volume of 34 cubic feet. The box he will use has a base of 15 square feet and a height of 3 feet. The rest of the box will be filled with packing material.

- B. What is the volume, in cubic feet, of the packing material Luke will need? Show or explain all your work.

First, we needed to find out the base. Since it has 15 sq ft, I gave the base a length of 3 and a width of 5 feet. Next, I made the height 3 ft of course. Then I multiplied all the numbers together and got 45 cubic ft. Last, to find how much packing material is needed, I subtracted  $45 \text{ ft}^3 - 34 \text{ ft}^3$ . I got  $11 \text{ ft}^3$  of packing material

$11 \text{ ft}^3$  of packing material

The student has given the correct answer ( $11 \text{ ft}^3$  of packing material) and complete support. The student correctly explained how to calculate the volume of the box (. . . the base. Since it has 15 sq ft, I gave the base a length of 3 and a width of 5 feet. Next, I made the height 3 ft . . . Then I multiplied all the numbers together and got 45 cubic ft). The student then correctly subtracted the volume of the toy from the volume of the box ( $45 \text{ ft}^3 - 34 \text{ ft}^3$ ). [2 points]

17. **Continued.** Please refer to the previous page for task explanation.

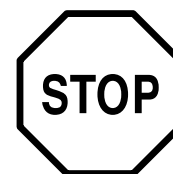
Luke has a toy, shaped like a rectangular prism, that needs to be sent in a box. The measurements of the toy are 8 inches long, 5 inches wide, and 6 inches high. To make sure there is enough room for the packing material, the measurements of the box need to be at least 1 inch greater than the length, width, and height of the toy. The box's volume must be less than 400 cubic inches.

- C. Explain why there is only one possible combination of length, width, and height of the box.

There is only one possibility because the highest numbers each length can get is 9, 6, and 7.  $9 \times 6 \times 7 = 378$  inches<sup>3</sup>. Any number that's higher is over 400. For example, with 10 instead of 9, you would get  $10 \times 6 \times 7 = 420$ . With 7 instead of 6 you would get  $9 \times 7 \times 7 = 441$ . Last, if you took 8 instead of 7, you would get  $9 \times 6 \times 8 = 432$ . So the lowest amount of inches high, long, and wide is 7, 9, 6. Which gives you 378 inches<sup>3</sup>.

The student has given a complete explanation that includes the correct combination (There is only one possibility because the highest numbers each length can get is 9, 6, and 7.  $9 \times 6 \times 7 = 378$  inches<sup>3</sup>) and further explains why only that combination works (Any number that's higher is over 400. For example, with 10 instead of 9, you would get  $10 \times 6 \times 7 = 420$ . With 7 instead of 6 you would get  $9 \times 7 \times 7 = 441$ . Last, if you took 8 instead of 7, you would get  $9 \times 6 \times 8 = 432$ ). [1 point]

After you have checked your work, close your answer booklet and test booklet so your teacher will know you are finished.



## STUDENT RESPONSE

Response Score: 3 points

## PART A



Question 17  
Page 1 of 2

Item ID ?

Luke works in the shipping department of a toy company. He sends toys in boxes that are each in the shape of a rectangular prism. The lengths, widths, and heights of all the boxes are whole numbers of inches.

Luke needs to find a box that has a total volume of 24 cubic inches.

A. Find a possible combination of length, width, and height, all in whole numbers of inches, of a box Luke could use.

EQ

6 = Length    2 = width    2 = height

The student has given a correct answer (6 = *Length*, 2 = *width*, 2 = *height*). These three whole numbers (6, 2, and 2) have a product of 24. [1 point]

Luke is shipping another toy that has a volume of 34 cubic feet. The box he will use has a base of 15 square feet and a height of 3 feet. The rest of the box will be filled with packing material.

B. What is the volume, in cubic feet, of the packing material Luke will need? Show or explain all your work.

EQ

$15 \times 3 = 45 \text{ cubic feet}$   
 $45 - 34 = 11 \text{ cubic feet}$

Luke will need a volume of 11 cubic feet of packing material.

The student has given the correct answer (Luke will need a volume of 11 cubic feet of packing material) and complete support. The student correctly calculated the volume of the box ( $15 \times 3 = 45 \text{ cubic feet}$ ). The student then correctly subtracted the volume of the toy from the volume of the box ( $45 - 34 = 11 \text{ cubic feet}$ ). [2 points]

101 / 1000

Review/End Test    Pause    Flag    Options    Next

Question 17  
Page 2 of 2

Item ID ?

Luke works in the shipping department of a toy company. He sends toys in boxes that are each in the shape of a rectangular prism. The lengths, widths, and heights of all the boxes are whole numbers of inches.

Luke has a toy, shaped like a rectangular prism, that needs to be sent in a box. The measurements of the toy are 8 inches long, 5 inches wide, and 6 inches high. To make sure there is enough room for the packing material, the measurements of the box need to be at least 1 inch greater than the length, width, and height of the toy. The box's volume must be less than 400 cubic inches.

C. Explain why there is only one possible combination of length, width, and height of the box.

Eq

Lukes toy is shaped like a rectangular prism, and the box is shaped like a cube, the box has to be bigger then the toy. The problem also says it has to be less then 400 cubic inches. Since volume = Length x width (area) x hight, you would have to multiply. There are not many, in fact only one combination that contains all of the things the problem wants. That is why there is only one possible combination of length, width and hight.

The student has given an incorrect explanation that does not explain why there is only one possible combination for the length, width, and height of the box. [0 points]

435 / 1000

Review/End Test Pause Flag Options Back Next

## STUDENT RESPONSE

## Response Score: 2 points

17. Luke works in the shipping department of a toy company. He sends toys in boxes that are each in the shape of a rectangular prism. The lengths, widths, and heights of all the boxes are whole numbers of inches.

Luke needs to find a box that has a total volume of 24 cubic inches.

- A. Find a possible combination of length, width, and height, all in whole numbers of inches, of a box Luke could use.

2 in long 3 in high 4 in wide

The student has given a correct answer (2 in long, 3 in high, 4 in wide). These three whole numbers (2, 3, and 4) have a product of 24. [1 point]

Luke is shipping another toy that has a volume of 34 cubic feet. The box he will use has a base of 15 square feet and a height of 3 feet. The rest of the box will be filled with packing material.

- B. What is the volume, in cubic feet, of the packing material Luke will need? Show or explain all your work.

$15 \times 3 = 45 \text{ ft}^3$   
 (base) (height)  

$$\begin{array}{r} 45 \\ -34 \\ \hline 9 \end{array} \text{ ft}^3 \text{ for packing material}$$

The student has given an incorrect answer (9 ft<sup>3</sup> for packing material) but complete support (all the correct steps are shown). The student correctly calculated the volume of the box ( $15 \times 3 = 45 \text{ ft}^3$ ). The student also correctly set up the subtraction of the volume of the toy from the volume of the box ( $45 - 34$ ); however, a calculation error in the subtraction resulted in an incorrect answer. [1 point]

Go to the next page to finish question 17.



17. **Continued.** Please refer to the previous page for task explanation.

Luke has a toy, shaped like a rectangular prism, that needs to be sent in a box. The measurements of the toy are 8 inches long, 5 inches wide, and 6 inches high. To make sure there is enough room for the packing material, the measurements of the box need to be at least 1 inch greater than the length, width, and height of the toy. The box's volume must be less than 400 cubic inches.

- C. Explain why there is only one possible combination of length, width, and height of the box.

The box has to be 8 in long, and 6 in high, and 6 wide. This is because when multiplied, it's product is  $288 \text{ in}^3$  it fullfills the requirement of being at least 1 in bigger than 240 in, and it is less than 400 in.

The box needs to be 8 long, 6 high, and 6 wide.

The student has given an incorrect explanation. The student has misunderstood the requirements of the box needing to be at least one inch larger than each of the toy's dimensions. The student has only increased the width by 1 inch, leaving the length and height the same (*The box has to be 8 in long, and 6 in high, and 6 wide*). [0 points]

**After you have checked your work, close your answer booklet and test booklet so your teacher will know you are finished.**





## STUDENT RESPONSE

Response Score: 1 point



## PART A

Question 17  
Page 1 of 2

Item ID ?

Luke works in the shipping department of a toy company. He sends toys in boxes that are each in the shape of a rectangular prism. The lengths, widths, and heights of all the boxes are whole numbers of inches.

Luke needs to find a box that has a total volume of 24 cubic inches.

A. Find a possible combination of length, width, and height, all in whole numbers of inches, of a box Luke could use.

EQ

L = 6 H = 4 W = 1 [6,4,1]

The student has given a correct answer ( $L = 6$ ,  $H = 4$ ,  $W = 1$ ). These three whole numbers (6, 4, and 1) have a product of 24. [1 point]

Luke is shipping another toy that has a volume of 34 cubic feet. The box he will use has a base of 15 square feet and a height of 3 feet. The rest of the box will be filled with packing material.

B. What is the volume, in cubic feet, of the packing material Luke will need? Show or explain all your work.

EQ

The volume is 36 because  $15 + 15$  and  $3 + 3$  equal 36

The student has given an incorrect answer (*The volume is 36*) and incorrect support. The student has incorrectly added numbers from the prompt ( $15 + 15$  and  $3 + 3$  equal 36). [0 points]

51 / 1000

Review/End Test Pause Flag Options Next



Question 17  
Page 2 of 2

Item ID ?

Luke works in the shipping department of a toy company. He sends toys in boxes that are each in the shape of a rectangular prism. The lengths, widths, and heights of all the boxes are whole numbers of inches.

Luke has a toy, shaped like a rectangular prism, that needs to be sent in a box. The measurements of the toy are 8 inches long, 5 inches wide, and 6 inches high. To make sure there is enough room for the packing material, the measurements of the box need to be at least 1 inch greater than the length, width, and height of the toy. The box's volume must be less than 400 cubic inches.

C. Explain why there is only one possible combination of length, width, and height of the box.

Eq

there is only one possible combination because the toy and the packing material fit perfectly

The student has given an incorrect explanation that does not explain why there is only one possible combination for the length, width, and height of the box. [0 points]

93 / 1000

Review/End Test Pause Flag Options Back Next

## STUDENT RESPONSE

## Response Score: 0 points

17. Luke works in the shipping department of a toy company. He sends toys in boxes that are each in the shape of a rectangular prism. The lengths, widths, and heights of all the boxes are whole numbers of inches.

Luke needs to find a box that has a total volume of 24 cubic inches.

- A. Find a possible combination of length, width, and height, all in whole numbers of inches, of a box Luke could use.

Luke could  $6 \times 4 = 24$   
use the combination 5

The student has given an incorrect answer (Luke could use the combination  $6 \times 4 = 24$ ). The student has only provided two whole numbers that have a product of 24 instead of the three required. [0 points]

Luke is shipping another toy that has a volume of 34 cubic feet. The box he will use has a base of 15 square feet and a height of 3 feet. The rest of the box will be filled with packing material.

- B. What is the volume, in cubic feet, of the packing material Luke will need? Show or explain all your work.

$34 \times 15 = 510$   
The volume is 510  
because if you  
multiply  $34 \times 15$  you get  
the answer 510.

The student has given an incorrect answer (510) and incorrect support. The student has incorrectly multiplied two numbers from the prompt ( $34 \times 15 = 510$ ). [0 points]

Go to the next page to finish question 17.

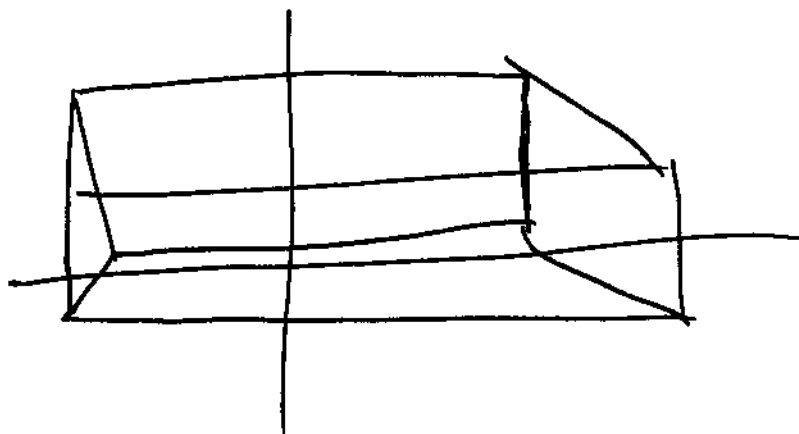


17. **Continued.** Please refer to the previous page for task explanation.

Luke has a toy, shaped like a rectangular prism, that needs to be sent in a box. The measurements of the toy are 8 inches long, 5 inches wide, and 6 inches high. To make sure there is enough room for the packing material, the measurements of the box need to be at least 1 inch greater than the length, width, and height of the toy. The box's volume must be less than 400 cubic inches.

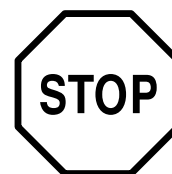
- C. Explain why there is only one possible combination of length, width, and height of the box.

No because length and width  
or height cant be used  
for a rectangle because  
its to long and wide.



The student has given an incorrect explanation that does not explain why there is only one possible combination for the length, width, and height of the box. [0 points]

**After you have checked your work, close your answer booklet and test booklet so your teacher will know you are finished.**



## MATHEMATICS—SUMMARY DATA

## Multiple-Choice

Sample Number	Alignment	Answer Key	Depth of Knowledge	p-value A	p-value B	p-value C	p-value D
1	A-T.2.1.1	A	1	69%	9%	7%	15%
2	A-T.1.1.1 A-T.1.1.3	C	2	11%	33%	34%	22%
3	A-T.1.1.4	A	1	63%	10%	13%	14%
4	A-T.1.1.5 A-T.2.1.3	D	2	13%	26%	7%	54%
5	A-T.2	B	2	8%	74%	10%	8%
6	A-T.2.1.2 A-T.2.1.1	B	2	15%	60%	9%	16%
7	A-F.2.1	C	2	17%	30%	38%	15%
8	A-F.2.1.2	A	2	56%	13%	21%	10%
9	A-F.2.1.3	A	2	48%	19%	16%	17%
10	B-O.1.1.1 B-O.1.1.2	C	2	14%	16%	53%	17%
11	B-O.1.1.2	A	2	72%	10%	11%	7%
12	B-O.2.1	D	2	24%	31%	8%	37%
13	C-G.1.1.1	C	1	8%	6%	67%	19%
14	C-G.1.1.2	D	2	5%	9%	23%	63%
15	C-G.2.1.1 C-G.1.1.2	A	2	58%	16%	16%	10%
16	D-M.1.1.1	B	1	24%	67%	5%	4%

## Open-Ended

Sample Number	Alignment	Points	Depth of Knowledge	Mean Score
17	D-M.3	4	3	1.25