Mathematics | Grade 5

In Grade 5, instructional time should focus on three critical areas: (1) developing fluency with addition and subtraction of fractions, and developing understanding of the multiplication of fractions and of division of fractions in limited cases (unit fractions divided by whole numbers and whole numbers divided by unit fractions); (2) extending division to 2-digit divisors, integrating decimal fractions into the place value system and developing understanding of operations with decimals to hundredths, and developing fluency with whole number and decimal operations; and (3) developing understanding of volume.

(1) Students apply their understanding of fractions and fraction models to represent the addition and subtraction of fractions with unlike denominators as equivalent calculations with like denominators. They develop fluency in calculating sums and differences of fractions, and make reasonable estimates of them. Students also use the meaning of fractions, of multiplication and division, and the relationship between multiplication and division to understand and explain why the procedures for multiplying and dividing fractions make sense. (Note: this is limited to the case of dividing unit fractions by whole numbers and whole numbers by unit fractions.)

(2) Students develop understanding of why division procedures work based on the meaning of base-ten numerals and properties of operations. They finalize fluency with multi-digit addition, subtraction, multiplication, and division. They apply their understandings of models for decimals, decimal notation, and properties of operations to add and subtract decimals to hundredths. They develop fluency in these computations, and make reasonable estimates of their results. Students use the relationship between decimals and fractions, as well as the relationship between finite decimals and whole numbers (i.e., a finite decimal multiplied by an appropriate power of 10 is a whole number), to understand and explain why the procedures for multiplying and dividing finite decimals make sense. They compute products and quotients of decimals to hundredths efficiently and accurately.

(3) Students recognize volume as an attribute of three-dimensional space. They understand that volume can be measured by finding the total number of same-size units of volume required to fill the space without gaps or overlaps. They understand that a 1-unit by 1-unit by 1-unit cube is the standard unit for measuring volume. They select appropriate units, strategies, and tools for solving problems that involve estimating and measuring volume. They decompose three-dimensional shapes and find volumes of right rectangular prisms by viewing them as decomposed into layers of arrays of cubes. They measure necessary attributes of shapes in order to determine volumes to solve real world and mathematical problems.
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Grade 5 Overview

Operations and Algebraic Thinking

• Write and interpret numerical expressions.
• Analyze patterns and relationships.

Number and Operations in Base Ten

• Understand the place value system.
• Perform operations with multi-digit whole numbers and with decimals to hundredths.

Number and Operations—Fractions

• Use equivalent fractions as a strategy to add and subtract fractions.
• Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

Measurement and Data

• Convert like measurement units within a given measurement system.
• Represent and interpret data.
• Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.

Geometry

• Graph points on the coordinate plane to solve real-world and mathematical problems.
• Classify two-dimensional figures into categories based on their properties.

Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.
Write and interpret numerical expressions. (5.OA.A)

1. Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols. (5.OA.A.1) (DOK 1)
   a. Example: Solution (DOK 1)
      Evaluate the following numerical expressions.

      a. $2 \times 5 + 3 \times 2 + 4$
      b. $2 \times (5 + 3 \times 2 + 4)$
      c. $2 \times 5 + 3 \times (2 + 4)$
      d. $2 \times (5 + 3) \times 2 + 4$
      e. $(2 \times 5) + (3 \times 2) + 4$
      f. $2 \times (5 + 3) \times (2 + 4)$

      Can the parentheses in any of these expressions be removed without changing the value of the expression?

   b. Example: Solution (DOK 2)
      Materials:
      - 4 dice per team
      - Recording sheet
      - Two-minute timer for each turn

      Action:
      Have students work in groups of 2 - 4. Introduce the game with an example, and then have them play independently. Discussion of "challenging rolls" afterwards can be productive.

      Students roll the 4 dice to generate their seed numbers. They then use those 4 numbers to create as many numbers as they can (1 - 10). Scoring is done as in bowling; numbered "pins" are "knocked down" by creating an expression equal to the number.

      The game can be structured in two different ways to assure that students are checking each other’s expressions and verifying that they are written as intended:

      a. During a student’s turn, have them record just the expressions (not the intended result), and then pass the set to another student (a judge). That judge then computes each expression as written and records which pins were knocked down.
b. Have the students play in teams. Each team tries to achieve a "strike" (knocking down all of the pins, which is almost always possible). Striving for the strike encourages students to brainstorm strategies for the "difficult" numbers, which leads them to discuss parts of each expression they have created already.

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</table>

c. Example: Solution (DOK 1)

What numbers can you make with 1, 2, 3, and 4? Using the operations of addition, subtraction, and multiplication, we can make many different numbers. For example, we can write 13 as

\[ 13 = (3 \times 4) + 1 \]

You can use parentheses as many times as you like and each of the numbers 1, 2, 3, and 4 can be used at most once.

a. Find two different ways to make 9.

b. Find two different ways to make 7.

c. Find two different ways to make 11.

d. Can you make 26?

2. Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them. For example, express the calculation "add 8 and 7, then multiply by 2" as \(2 \times (8 + 7)\). Recognize
that $3 \times (18932 + 921)$ is three times as large as $18932 + 921$, without having to calculate the indicated sum or product. (5.OA.A.2) (DOK 1,2)

a. Example: Solution (DOK 2)
Leo and Silvia are looking at the following problem:

How does the product of $60 \times 225$ compare to the product of $30 \times 225$?

Silvia says she can compare these products without multiplying the numbers out. Explain how she might do this. Draw pictures to illustrate your explanation.

b. Example: Solution (DOK 1)
Write an expression that records the calculations described below, but do not evaluate.

*Add 2 and 4 and multiply the sum by 3. Next, add 5 to that product and then double the result.*

c. Example: Solution (DOK 2)
Eric is playing a video game. At a certain point in the game, he has 31500 points. Then the following events happen, in order:

- He earns 2450 additional points.
- He loses 3310 points.
- The game ends, and his score doubles.

a. Write an expression for the number of points Eric has at the end of the game. Do not evaluate the expression. The expression should keep track of what happens in each step listed above.

b. Eric's sister Leila plays the same game. When she is finished playing, her score is given by the expression

$$3(24500 + 3610) - 6780.$$ 

Describe a sequence of events that might have led to Leila earning this score.

d. Example: Solution (DOK 3)
Below is a picture that represents $9 + 2$.

```
  9+2
```

a. Draw a picture that represents $4 \times (9 + 2)$.

b. How many times bigger is the value of $4 \times (9 + 2)$ than $9 + 2$? Explain your reasoning.

e. Example: Tyler is 8 years old. His sister Olivia is 4 years less than twice his age. Write a numerical expression for Olivia's age.
Analyze patterns and relationships. (5.OA.B)

1. Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns, and graph the ordered pairs on a coordinate plane. For example, given the rule "Add 3" and the starting number 0, and given the rule "Add 6" and the starting number 0, generate terms in the resulting sequences, and observe that the terms in one sequence are twice the corresponding terms in the other sequence. Explain informally why this is so. (5.OA.B.3) (DOK 1, 2)

   a. Example: Solution (DOK 2)

   Cora and Cecilia each use chalk to make their own number patterns on the sidewalk. They make each of their patterns 10 boxes long and line their patterns up so they are next to each other.

   Cora puts 0 in her first box and decides that she will add 3 every time to get the next number.

   Cecilia puts 0 in her first box and decides that she will add 9 every time to get the next number.

   Cora:
   \[
   \begin{array}{c}
   0 \\
   3 \\
   \end{array}
   \]

   Cecilia:
   \[
   \begin{array}{c}
   0 \\
   9 \\
   \end{array}
   \]

   a. Complete each girl’s sidewalk pattern.

   b. How many times greater is Cecilia’s number in the 5th box be than Cora’s number in the 5th box? What about the numbers in the 8th box? The 10th box?

   c. What pattern do you notice in your answers for part b? Why do you think that pattern exists?

   d. If Cora and Cecilia kept their sidewalk patterns going, what number will be in Cora’s box when Cecilia’s corresponding box shows 153?

Example: (Former NAEP question) (DOK 1)
The first four terms in a sequence are shown below.

40, 8, 24, 16, ...

Each term after the first two terms is found by taking one-half the sum of the two preceding terms. Which term is the first odd number in this sequence?

A. The 5th term
B. The 6th term
C. The 7th term
D. The 8th term
E. The 9th term

Answer: C, the 7th term
Example: Five swimmers compete in the 50-meter race. The finish time for each swimmer is shown.

```
23.42
23.18
23.21
23.35
23.24
```

Men's 50 Meter Freestyle

Explain how the results of the race would change if the race used a clock that rounded to the nearest tenth.

(DOK 3)

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<th>Key</th>
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</table>
| #28  | 3     | NS     | 3D, 3F | 1   | 5.NBT.3 | N/A| Sample top-score response: There would be three swimmers with the same time, and the other two swimmers would also have the same time. Instead of having one clear winner, there would be a tie for first place.
|      |       |        |        |     |         |    | For full credit: The response demonstrates a full and complete understanding of communicating reasoning. The response contains the following evidence:
|      |       |        |        |     |         |    | -The student explains how the race results would change (e.g. three swimmers would tie for first place) |

Example: Choose True or False for each equation. (DOK 2)

A. $37 \times 4 = 1,480 \div 10$  ○ True  ○ False
B. $215 \times 39 = 2,487 \div 3$  ○ True  ○ False
C. $4,086 \times 7 = 32,202$  ○ True  ○ False
D. $9,130 \times 86 = 785,180$  ○ True  ○ False
Understand the place value system. (5.NBT.A)

1. Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left. (5.NBT.A.1) (DOK 1)
   a. Example: Solution (DOK 3)
      a. Kipton has a digital scale. He puts a marshmallow on the scale and it reads 7.2 grams. How much would you expect 10 marshmallows to weigh? Why?
      b. Kipton takes the marshmallows off the scale. He then puts on 10 jellybeans and then scale reads 12.0 grams. How much would you expect 1 jellybean to weigh? Why?
      c. Kipton then takes off the jellybeans and puts on 10 brand-new pink erasers. The scale reads 312.4 grams. How much would you expect 1,000 pink erasers to weigh? Why?
   b. Example: Solution (DOK 3)
      Netta drew a picture on graph paper:

      ![Graph paper drawing]

      She said,

      *In my picture, a big square represents 1. Since ten rectangles make a big square, a rectangle represents 0.1. Since 100 little squares make a big square, a little square represents 0.01. So this picture represents 2.43.*

      a. Is Netta Correct?

      Manny said,

      *I drew the same picture, but in my picture, a little square represents 1, so this picture represents 243.*

      b. Name some other numbers that this picture could represent. For each of these numbers, what does a rectangle represent? What does a square represent? Explain.

      c. Draw a picture to represent 0.047.
   c. Example: Solution (DOK 2)
Jossie drew a picture to represent 0.24:

She said,

*The little squares represent tenths and the rectangles represent hundredths, which makes sense because ten little squares makes one rectangle, and ten times ten is one hundred.*

a. Explain what is wrong with Jossie's reasoning.

b. Name three numbers that Jossie's picture could represent. In each case, What does a little square represent? What does a rectangle represent?

d. Example: Solution (DOK 1)

Historians estimate that there were about 7 million people on the earth in 4,000 BCE. Now there are about 7 billion! We write 7 million as 7,000,000. We write 7 billion as 7,000,000,000. How many times more people are there on the earth now than there were in 4,000 BCE?

2. Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10. (5.NBT.A.2) (DOK 1,2)

a. Example: Solution (DOK 2)

Marta made an error while finding the product $84.15 \times 10$.

In your own words, explain Marta's misunderstanding. Please explain what she should do to get the correct answer and include the correct answer in your response.

b. Example: Solution (DOK 3)
a. Explain why \( 0.4 \times 10 = 4 \)
b. Explain why \( 3.4 \times 10 = 34 \)

Draw pictures to illustrate your explanations.

c. Example: Which number is equal to \( 10^4 \)? (DOK 1)
   1. 100
   2. 1,000
   3. 10,000
   4. 100,000

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<td>C</td>
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d. Example: (Former NAEP question) (DOK 1)

Which of the following represents fifteen tens?

A. 15
B. 150
C. 1,500
D. 1,510

Answer: B, 150

1. Read, write, and compare decimals to thousandths.
   a. Read and write decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., \( 347.392 = 3 \times 100 + 4 \times 10 + 7 \times 1 + 3 \times (1/10) + 9 \times (1/100) + 2 \times (1/1000) \).
   b. Compare two decimals to thousandths based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons. (5.NBT.A.3) (DOK 1)

   1. Example: Solution (DOK 2)
      a. Which is greater, 0.01 or 0.001? Explain. Draw a picture to illustrate your explanation.
      b. Which is greater, 0.03 or 0.007? Explain. Draw a picture to illustrate your explanation.
      c. Which is greater, 0.025 or 0.052? Explain. Draw a picture to illustrate your explanation.
      d. Which is greater, 0.13 or 0.031? Explain. Draw a picture to illustrate your explanation.
      e. Which is greater, 0.203 or 0.21? Explain. Draw a picture to illustrate your explanation.

   2. Example: Solution (DOK 1)
a. Which is greater, 0.1 or 0.01? Show the comparison on the number line.

b. Which is greater, 0.2 or 0.03? Show the comparison on the number line.

c. Which is greater, 0.12 or 0.21? Show the comparison on the number line.

d. Which is greater, 0.13 or 0.031? Show the comparison on the number line.

3. Example: **Solution** (DOK 1)
Label all of the tick marks on the number line.

Plot and label each of the following numbers on the number line.

| 0.100 | 0.010 | 0.072 | 0.038 |

Which of these numbers is greatest? Which is least? How can you tell by looking at the number line?

4. Example: **Solution** (DOK 2)
Isaiah is thinking of the number 9.52 in his head. Decide whether each of these has the same value as 9.52 and discuss your reasoning.

   a. Nine and fifty-two tenths
   b. $9 + 0.5 + 0.02$
   c. 9 ones + 5 tenths + 2 hundredths
   d. $(9 \times 1) + \left(5 \times \frac{1}{10}\right) + \left(2 \times \frac{1}{100}\right)$
   e. 952 tenths
   f. 952 hundredths
5. Example: Which number makes this inequality true?

$$4253.647 > \square$$

a. 4253.664  
b. 4253.655  
c. 4253.649  
d. 4253.638

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6. Example: [Former NAEP question] (DOK 1)

Ben bought 4 items at a bake sale and added their cost on his calculator. The total cost read 1.1 on the calculator. What amount does Ben need to pay?

- F. 11 cents
- G. 1 dollar and 1 cent
- H. 1 dollar and 10 cents
- I. 11 dollars

Answer: H, 1 dollar and 10 cents

7. Example: [Former NAEP question] (DOK 1)

Which number is forty-five and six hundredths?

A. 45.6  
B. 45.06  
C. 456.0  
D. 645.0

Answer: B

8. Example: [Former NAEP question] (DOK 1)
In which of the following numbers is the digit 6 in the hundredths place?

A. 682.3
B. 382.6
C. 6.832
D. 4.836
E. 2.862

Answer: E

9. Example: ([Former NAEP question] (DOK 1)

Which number is smallest?

A. 0.01
B. 0.001
C. 0.101
D. 0.1

Answer: B

10. Example: ([Former NAEP question] (DOK 1)

What is the number in the box? 
A. Seven hundredths 
B. Seven tenths 
C. Seven 
D. Seventy

Answer: A

11. Example: ([Former NAEP question] (DOK 1)

Which number is between 0.09 and 0.1?

A. 0.95
B. 0.5
C. 0.095
D. 0.05

Answer: A

12. Example: ([Former NAEP question] (DOK 1)

Which number is between 1.8 and 1.9?

A. 0.189
B. 0.198
C. 1.83
D. 1.93

Answer: C

2. Use place value understanding to round decimals to any place. ([S.NBT.A.4] (DOK 1)

a. Example: Solution (DOK 1)
Perform operations with multi-digit whole numbers and with decimals to hundredths. (5.NBT.B)

3. Fluently multiply multi-digit whole numbers using the standard algorithm. (5.NBT.B.5) (DOK 1)
   a. Example: Solution (DOK 2)
      This is Elmer’s work on a multiplication problem:

      \[
      \begin{array}{c}
      179 \\
      \times 64 \\
      \hline
      716 \\
      \hline
      11074 \\
      \hline
      11790
      \end{array}
      \]

      a. Use estimation to explain why Elmer’s answer is not reasonable.
      b. What error do you think Elmer made? Why do you think he made that error?
      c. Find \(179 \times 64\) using a correct version of Elmer’s method. Then show another way of doing it to help Elmer see why your answer is correct.

   b. Example: Write the product. (DOK 1)
      \[4238 \times 32 = \]
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c. Example: (Former NAEP question) (DOK 2)

\[
\frac{47 \times 75}{25} =
\]

A. 141  
B. 1,175  
C. 3,525  
D. 4,700

Answer: A

d. Example: (Former NAEP question) (DOK 2)

The booster club is planning to buy peanuts to serve at its meetings. The cost of the peanuts depends on the amount purchased, as shown in the table below.

<table>
<thead>
<tr>
<th>Total Number of Pounds Purchased</th>
<th>Cost of Peanuts Per Pound</th>
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<tbody>
<tr>
<td>0 - 5</td>
<td>$2.50</td>
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<tr>
<td>6 - 10</td>
<td>$2.25</td>
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<tr>
<td>11 - 20</td>
<td>$2.00</td>
</tr>
<tr>
<td>Over 20</td>
<td>$1.75</td>
</tr>
</tbody>
</table>

How much will 18 pounds of peanuts cost?

A. $31.50  
B. $34.00  
C. $36.00  
D. $40.50  
E. $45.00

Answer: C

4. Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models. (5.NBT.B.6) (DOK 1,2)

a. Example: Solution (DOK 2)

What time was it 2011 minutes after the beginning of January 1, 2011?

b. Example: Jasmine solves the equation \( \square \div 4 = 363 \) using this area model.
Which statement explains how Jasmine should solve for the missing number in the model?
1. Jasmine should divide 60 by 4.
2. Jasmine should divide 1200 by 12.
3. Jasmine should multiply 3 times 60.
4. Jasmine should multiply 4 times 60.

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c. Example: Write the quotient. (DOK 1)
3125 ÷ 25 =

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d. Example: (Former NAEP question) (DOK 2)
Mr. Jones picked a number greater than 100.
He told Gloria to divide the number by 18.

He told Edward to divide the number by 15.

Whose answer is greater?

○ Gloria’s   ○ Edward’s

Explain how you know this person’s answer will always be greater for any number that Mr. Jones picks.
Answer: Edward, because he is dividing by a small number, the pieces will always be bigger.

e. Example: (Former NAEP question) (DOK 1)
There will be 58 people at a breakfast and each person will eat 2 eggs. There are 12 eggs in each carton.
How many cartons of eggs will be needed for the breakfast?

A. 9
B. 10
C. 72
D. 116

Answer: B, 10
5. Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. (5.NBT.B.7) (DOK 1,2,3)

   a. Example: Solution (DOK 2)
      i. Jessa has 23 one-dollar bills that she wants to divide equally between her 5 children.
         ii. How much money will each receive? How much money will Jessa have left over?

   b. A website has games available to purchase for $5 each. If Lita has $23, how many games can she purchase? Explain.

   c. A jug holds 5 gallons of water. How many jugs can Mark fill with 23 gallons of water? Explain.

   d. A class of 23 children will take a field trip. Each car can take 5 children. How many cars are needed to take all the children on the field trip? Explain.

   e. Write a division problem for $31 \div 4$ where the answer is a mixed number. Show how to solve your problem.

b. Example: Solution (DOK 2)

   The table shows four people who earn the typical amount for their education level.

<table>
<thead>
<tr>
<th>Name</th>
<th>Level of Education</th>
<th>Weekly Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miley</td>
<td>High School Dropout</td>
<td>$440.50</td>
</tr>
<tr>
<td>Niko</td>
<td>High School Graduate</td>
<td>$650.35</td>
</tr>
<tr>
<td>Taylor</td>
<td>2-Year College Graduate</td>
<td>$771.25</td>
</tr>
<tr>
<td>Pinky</td>
<td>4-Year College Graduate</td>
<td>$1,099.20</td>
</tr>
</tbody>
</table>

   a. How much more does Niko earn than Miley in one week?

   b. If Taylor and Miley both work for 2 weeks, how much more will Taylor earn?

   c. How much money will Pinky earn in a month? About how long will Miley have to work to earn the same amount?

   c. Example: The bed of a truck is stacked with boxes of paper. The boxes are stacked 5 boxes deep by 4 boxes high by 4 boxes across, as shown in the picture. (DOK 2)
d. Example: Connor is buying tickets to a concert. The concert he and his friends want to see costs $4.75 per ticket. Connor has $26.00 total. (DOK 1)
What is the greatest number of tickets Connor can buy?
1. 4
2. 5
3. 6
4. 7

e. Example: Use this pentagon to solve the problem.
Write the perimeter, in centimeters, of the pentagon. (DOK 1)

f. Example: (Former NAEP question) (DOK 1)
Multiply: \[
\begin{array}{c}
8.5 \\
\times 4.9
\end{array}
\]

Answer: 41.65

g. Example: (Former NAEP question) (DOK 1)

Joe rode his bicycle from his house to his friend’s house. He rode 1.7 miles along the path below.

The path is marked every 0.5 mile.

Put an X on the path to show how far Joe rode to his friend’s house.

\[= 0.5 \text{ mile}\]

h. Example: (Former NAEP question) (DOK 2)

Carlos bought the cereal and milk shown. Use the table to find out the total amount Carlos spent, including tax.

<table>
<thead>
<tr>
<th>Amount of Sales</th>
<th>Amount of Tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>$6.00</td>
<td>$0.36</td>
</tr>
<tr>
<td>$6.20</td>
<td>$0.37</td>
</tr>
<tr>
<td>$6.40</td>
<td>$0.38</td>
</tr>
<tr>
<td>$6.60</td>
<td>$0.40</td>
</tr>
<tr>
<td>$6.80</td>
<td>$0.41</td>
</tr>
<tr>
<td>$7.00</td>
<td>$0.42</td>
</tr>
<tr>
<td>$7.20</td>
<td>$0.43</td>
</tr>
<tr>
<td>$7.40</td>
<td>$0.44</td>
</tr>
<tr>
<td>$7.60</td>
<td>$0.46</td>
</tr>
<tr>
<td>$7.80</td>
<td>$0.47</td>
</tr>
<tr>
<td>$8.00</td>
<td>$0.48</td>
</tr>
</tbody>
</table>

Total amount spent: 

Show how you found your answer.

Answer: $10.66 (rounded). First add the prices of cereal and milk, then multiply the amount by the tax to find the taxed number. Then, add the tax to the milk+cereal total.

i. Example: (Former NAEP question) (DOK 1)
A pack of stickers cost $2.49 and a book costs $1.85. How much MORE do the stickers cost than the book?
A. $0.64
B. $0.74
C. $1.85
D. $4.34
E. $5.34

Answer: A

j. Example: (Former NAEP question) (DOK 2)

Last week Maureen earned $288.00 (before taxes) for working 40 hours. This week Maureen worked 29 hours at the same rate of pay. How much did Maureen earn (before taxes) this week?
A. $72.00
B. $72.50
C. $203.00
D. $208.80
E. $397.24

Answer: D

k. Example: (Former NAEP question) (DOK 2)

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yogurt</td>
<td>$0.95</td>
</tr>
<tr>
<td>Pretzels</td>
<td>$2.50 per bag</td>
</tr>
<tr>
<td>Cheese cubes</td>
<td>$2.19 per bag</td>
</tr>
<tr>
<td>Bagel</td>
<td>$0.89</td>
</tr>
<tr>
<td>Fruit drink</td>
<td>$1.85 each</td>
</tr>
<tr>
<td>Peanuts</td>
<td>$2.55 per bag</td>
</tr>
</tbody>
</table>

Robert has $30 and wants to buy as many bags of peanuts as possible. He does not have to pay any sales tax on the food that he buys.

Based on the prices given in the chart above, how many bags of peanuts can Robert buy?

Robert buys all the bags of peanuts that he can. What is the most expensive single item on the chart that he can buy with the money he has left?

Answer: Robert can buy 11 bags of peanuts. He can then buy a fruit drink with the remaining $1.95 he has.

l. Example: (Former NAEP question) (DOK 2)

It costs $0.25 to operate a clothes dryer for 10 minutes at a laundromat. What is the total cost to operate one clothes dryer for 30 minutes, a second for 40 minutes, and a third for 50 minutes?
A. $3.25
B. $3.00
C. $2.75
D. $2.00
E. $1.20

Answer: B

m. Example: (Former NAEP question) (DOK 2)

Peter bought 45 sheets of plywood at a total cost of $400. He plans to sell each sheet of plywood for $15. If Peter has no other expenses, what is the fewest number of sheets he must sell to make a profit?
A. 3
B. 15
C. 16
D. 26
E. 27
n. Example: (Former NAEP question) (DOK 1)
What is the greatest number of 30-cent apples that can be purchased with $5.00?
A. 6
B. 15
C. 16
D. 17
E. 20

Answer: C

o. Example: (Former NAEP question) (DOK 1)
Sally bought two tickets to a movie. Each ticket cost $4.25. She paid for the tickets with a $10 bill. How much change did she get?
A. $5.75
B. $5.25
C. $4.25
D. $1.75
E. $1.50

Answer: E

p. Example: (Former NAEP question) (DOK 1)
$360 \times 0.3 = $
A. 10.8
B. 108
C. 120
D. 980
E. 1,080

Answer: B
Use equivalent fractions as a strategy to add and subtract fractions. (5.NF.A)

1. Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. For example, \( \frac{2}{3} + \frac{5}{4} = \frac{8}{12} + \frac{15}{12} = \frac{23}{12} \). (In general, \( \frac{a}{b} + \frac{c}{d} = \frac{ad + bc}{bd} \).) (5.NF.A.1) (DOK 1)
   a. Example: Solution (DOK 3)

   Ancient Egyptians used unit fractions, such as \( \frac{1}{2} \) and \( \frac{1}{3} \), to represent all fractions. For example, they might write the number \( \frac{2}{3} \) as \( \frac{1}{2} + \frac{1}{6} \).

   ![Diagram showing representation of \( \frac{2}{3} \) as \( \frac{1}{2} + \frac{1}{6} \)]

   We often think of \( \frac{2}{3} \) as \( \frac{1}{3} + \frac{1}{3} \) but the ancient Egyptians would not write it this way because they didn't use the same unit fraction twice.

   a. Write each of the following Egyptian fractions as a single fraction:
      i. \( \frac{1}{2} + \frac{1}{3} \)
      ii. \( \frac{1}{3} + \frac{1}{3} + \frac{1}{5} \)
      iii. \( \frac{1}{4} + \frac{1}{5} + \frac{1}{12} \).

   b. How might the ancient Egyptians have written the fraction we write as \( \frac{3}{4} \)?
   b. Example: Solution (DOK 2)

   Find two different ways to add these two numbers:

   \[ \frac{1}{3} + \frac{3}{5} \]

   c. Example: Solution (DOK 2)
a. To add fractions, we usually first find a common denominator.
   i. Find two different common denominators for $\frac{1}{5}$ and $\frac{1}{15}$
   ii. Use each common denominator to find the value of $\frac{1}{5} + \frac{1}{15}$.
    Draw a picture that shows your solution.

b. Find $\frac{3}{4} + \frac{1}{6}$. Draw a picture that shows your solution.

c. Find $\frac{11}{8} + \frac{15}{12}$.

d. Example: Solution (DOK 1)
   Alex is training for his school's Jog-A-Thon and needs to run at least 1 mile per day. If Alex runs to his grandma's house, which is $\frac{5}{8}$ of a mile away, and then to his friend Justin's house, which is $\frac{1}{2}$ of a mile away, will he have trained enough for the day?

e. Example: Solution (DOK 2)
   a. To subtract fractions, we usually first find a common denominator.
      i. Find two different common denominators for $\frac{1}{3}$ and $\frac{1}{14}$
      ii. Use each common denominator to find the value of $\frac{1}{3} - \frac{1}{14}$.
         Draw a picture that shows your solution.

b. Find $\frac{5}{9} - \frac{1}{6}$. Draw a picture that shows your solution.

c. Find $\frac{24}{10} - \frac{24}{15}$.

f. Example: Solution (DOK 2)
   Nick and Tasha are buying supplies for a camping trip. They need to buy chocolate bars to make s'mores, their favorite campfire dessert. Each of them has a different recipe for their perfect s'more. Nick likes to use $\frac{1}{2}$ of a chocolate bar to make a s'more. Tasha will only eat a s'more that is made with exactly $\frac{2}{3}$ of a chocolate bar.

   a. What fraction of a chocolate bar will Nick and Tasha use in total if they each eat one s'more?

   b. Nick wants to cut one chocolate bar into pieces of equal size so that he and Tasha can make their s'mores. How many pieces should he cut the chocolate bar into so that each person will get the right amount of chocolate to make their perfect s'more?

   c. After Nick cuts the chocolate bar into pieces of equal size, how many pieces of the chocolate bar should he get? How many pieces of the chocolate bar should he give to Tasha?
g. Example: Solution (DOK 2)
You and your partner will need fraction cards made from this set:

<table>
<thead>
<tr>
<th>1/8</th>
<th>1/8</th>
<th>1/8</th>
<th>1/8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8</td>
<td>1/8</td>
<td>1/8</td>
<td>1/8</td>
</tr>
<tr>
<td>1/4</td>
<td>1/4</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>1/4</td>
<td>1/4</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>1/2</td>
<td>1/2</td>
<td>1/2</td>
<td>1/2</td>
</tr>
<tr>
<td>1/2</td>
<td>1/2</td>
<td>1/2</td>
<td>1/2</td>
</tr>
</tbody>
</table>

a. Label the line-plot below with $\frac{1}{8}$'s. Cut out and divide the cards evenly between the two players, laying them face-down. Each partner will choose one of their face-down cards and turn it over. The team will then add their fractions together. For each turn, each team will record their sum on the line plot.

```
0  |  |  |  |  | 1
```

Each team should have 12 data points marked on their line plot.

b. Look at the line plot. Which values came up the most? Which values did not come up?

c. The tick marks on the number line correspond to eighths. Which of the eighths will never come up as a sum of two of these cards? Why?

d. You want to improve the game so that it is possible for two fractions to sum to $\frac{7}{8}$. Name one fraction card that you could add to the deck and explain why your new card would now make it possible to have $\frac{7}{8}$ as a sum of two cards.

h. Example: Select two fractions that can be rewritten with a denominator of 24.

1. $\frac{1}{6}$
2. $\frac{5}{12}$
3. $\frac{7}{9}$
4. $\frac{10}{12}$
5. $\frac{7}{8}$
6. $\frac{1}{8}$
2. Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers. For example, recognize an incorrect result \( \frac{2}{5} + \frac{1}{2} = \frac{3}{7} \), by observing that \( \frac{3}{7} < \frac{1}{2} \). (5.NF.A.2) (DOK 1,2,3)

a. Example: Solution (DOK 3)

For each of the following word problems, determine whether or not \( \left( \frac{2}{5} + \frac{3}{10} \right) \) represents the problem. Explain your decision.

a. A farmer planted \( \frac{3}{5} \) of his forty acres in corn and another \( \frac{3}{10} \) of his land in wheat. Taken together, what fraction of the 40 acres had been planted in corn or wheat?

b. Jim drank \( \frac{2}{5} \) of his water bottle and John drank \( \frac{3}{8} \) of his water bottle. How much water did both boys drink?

c. Allison has a batch of eggs in the incubator. On Monday \( \frac{2}{5} \) of the eggs hatched. By Wednesday, \( \frac{3}{10} \) more of the original batch hatched. How many eggs hatched in all?

d. Two fifths of the cross-country team arrived at the weight room at 7 a.m. Ten minutes later, \( \frac{4}{10} \) of the team showed up. The rest of the team stayed home. What fraction of the team made it to the weight room that day?

e. Andy made 2 free throws out of 5 free throw attempts. Jose made 3 free throws out of 10 free throw attempts. What is the fraction of free throw attempts that the two boys made together?

f. Two fifths of the students in the fifth grade want to be in the band. Three tenths of the students in the fifth grade want to play in the orchestra. What fraction of the students in the fifth grade want to be in one of the two musical groups?
g. There are 150 students in the fifth grade in Washington Elementary School. Two fifths of the students like soccer best and \( \frac{2}{5} \) of them like basketball best. What fraction like soccer or basketball best?

h. The fifth grade at Lincoln School has two mixed-sex soccer teams, Team A and Team B. If \( \frac{3}{8} \) of Team A are girls and \( \frac{3}{10} \) of Team B are girls, what fraction of the players from the two teams are girls?

i. Wesley ran \( \frac{5}{6} \) of a mile on Monday and \( \frac{3}{10} \) of a mile on Tuesday. How far did he run those two days?

b. Example: Solution (DOK 3)
Alex, Bryan, and Cynthia are about to eat lunch, and they have two sandwiches to share.

a. Draw a picture to show how they could equally share the sandwiches. How much of a sandwich does each person get?

b. Write an equation involving addition to show how together these parts make up the 2 sandwiches. Explain how the equation you wrote represents this situation.

c. Write an equation involving multiplication to show how all the parts make up the 2 sandwiches. Explain how the equation you wrote represents this situation.

d. Write an equation using multiplication to show the fraction of a sandwich each student gets. Explain how the equation you wrote represents this situation.

e. Write an equation using division to show the fraction of a sandwich each student gets. Explain how the equation you wrote represents this situation.

c. Example: Jason begins at the start of a path and rides his bike 11 \( \frac{3}{4} \) miles on the path. The path is 12 \( \frac{3}{4} \) miles long. Write the distance, in miles, Jason must ride to reach the end of the path.

<table>
<thead>
<tr>
<th>Item</th>
<th>Claim</th>
<th>Domain</th>
<th>Target</th>
<th>DOK</th>
<th>CONTENT</th>
<th>MP</th>
<th>Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>#19</td>
<td>1</td>
<td>NF</td>
<td>E</td>
<td>2</td>
<td>5.NF.A.2</td>
<td>N/A</td>
<td>( \frac{3}{4} )</td>
</tr>
</tbody>
</table>

d. Example: Jan measured the growth of a sunflower. (DOK 2)

- In week one, it grew \( 2 \frac{1}{2} \) inches.
- In week two, it grew \( 2 \frac{3}{4} \) inches.
- In week three, it grew \( 3 \frac{1}{4} \) inches.

How much did the sunflower grow over all three weeks?

1. \( 5 \frac{3}{4} \) in

2. \( 7 \frac{1}{2} \) in
Apply and extend previous understandings of multiplication and division to multiply and divide fractions. (5.NF.B)

3. Interpret a fraction as division of the numerator by the denominator (a/b = a ÷ b). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. For example, interpret 3/4 as the result of dividing 3 by 4, noting that 3/4 multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size 3/4. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie? (5.NF.B.3) (DOK 1,2)

a. Example: Solution (DOK 2)
a. Jessa has 23 one-dollar bills that she wants to divide equally between her 5 children.
   i. How much money will each receive? How much money will Jessa have left over?
   ii. Jessa exchanged the remaining one-dollar bills for dimes. If she divides the money equally between her 5 children, how much money will each child get?

b. A website has games available to purchase for $5 each. If Lita has $23, how many games can she purchase? Explain.

c. A jug holds 5 gallons of water. How many jugs can Mark fill with 23 gallons of water? Explain.

d. A class of 23 children will take a field trip. Each car can take 5 children. How many cars are needed to take all the children on the field trip? Explain.

e. Write a division problem for $31 \div 4$ where the answer is a mixed number. Show how to solve your problem.

b. Example: Solution (DOK 2)
   a. Five brothers are going to take turns watching their family’s new puppy. How much time will each brother spend watching the puppy in a single day if they all watch him for an equal length of time? Write your answer
      i. Using only hours,
      ii. Using a whole number of hours and a whole number of minutes, and
      iii. Using only minutes.

   b. Mrs. Hinojosa had 75 feet of ribbon. If each of the 18 students in her class gets an equal length of ribbon, how long will each piece be? Write your answer
      i. Using only feet,
      ii. Using a whole number of feet and a whole number of inches, and
      iii. Using only inches.

   c. Wesley walked 11 miles in 4 hours. If he walked the same distance every hour, how far did he walk in one hour? Write your answer
      i. Using only miles,
      ii. Using a whole number of miles and a whole number of feet, and
      iii. Using only feet.

c. Example: Solution (DOK 2)
After a class potluck, Emily has three equally sized apple pies left and she wants to divide them into eight equal portions to give to eight students who want to take some pie home.

a. Draw a picture showing how Emily might divide the pies into eight equal portions. Explain how your picture shows eight equal portions.

b. What fraction of a pie will each of the eight students get?

c. Explain how the answer to (b) is related to the division problem $3 \div 8$.

d. Example: Solution (DOK 2)

Alex, Bryan, and Cynthia are about to eat lunch, and they have two sandwiches to share.

a. Draw a picture to show how they could equally share the sandwiches. How much of a sandwich does each person get?

b. Write an equation involving addition to show how together these parts make up the 2 sandwiches. Explain how the equation you wrote represents this situation.

c. Write an equation involving multiplication to show how all the parts make up the 2 sandwiches. Explain how the equation you wrote represents this situation.

d. Write an equation using multiplication to show the fraction of a sandwich each student gets. Explain how the equation you wrote represents this situation.

e. Write an equation using division to show the fraction of a sandwich each student gets. Explain how the equation you wrote represents this situation.

e. Example: Darcy likes to eat peanut butter and raisins on apple slices. On each apple slice she puts $\frac{1}{16}$ cup of peanut butter and 8 raisins.

Darcy has $\frac{2}{5}$ cup of peanut butter and 80 raisins. She eats a whole number of apple slices until the peanut butter is all gone.

What fraction of 80 raisins did she eat?
Write the fraction.

<table>
<thead>
<tr>
<th>Item</th>
<th>Claim</th>
<th>Domain</th>
<th>Target</th>
<th>DOK</th>
<th>CONTENT</th>
<th>MP</th>
<th>Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>#14</td>
<td>4</td>
<td>NS, NF</td>
<td>A</td>
<td>3</td>
<td>6.NS.A, 5.NF.B.3</td>
<td>1, 6</td>
<td>$\frac{3}{5}$</td>
</tr>
</tbody>
</table>

4. Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.

a. Interpret the product $(a/b) \times q$ as a part of a partition of $q$ into $b$ equal parts; equivalently, as the result of a sequence of operations $a \times q \div b$. For example, use a visual fraction model to show $(2/3) \times 4 = 8/3$, and create a story context for this equation. Do the same with $(2/3) \times (4/5) = 8/15$. (In general, $(a/b) \times (c/d) = ac/bd$.)

b. Find the area of a rectangle with fractional side lengths by tiling it with unit squares of the
appropriate unit fraction side lengths, and show that the area is the same as would be found by multiplying the side lengths. Multiply fractional side lengths to find areas of rectangles, and represent fraction products as rectangular areas. *(5.NF.B.4)* *(DOK 1,2)*

1. Example: **Solution** *(DOK 3)*
   Makayla said, "I can represent $3 \times \frac{2}{3}$ with 3 rectangles each of length $\frac{2}{3}$.*

![Diagram of rectangles]

Connor said, "I know that $\frac{2}{3} \times 3$ can be thought of as $\frac{2}{3}$ of 3. Is 3 copies of $\frac{2}{3}$ the same as $\frac{2}{3}$ of 3?"

a. Draw a diagram to represent $\frac{2}{3}$ of 3.

b. Explain why your picture and Makayla’s picture together show that $3 \times \frac{2}{3} = \frac{2}{3} \times 3$.

c. What property of multiplication do these pictures illustrate?

2. Example: **Solution** *(DOK 2)*
   a. Label the points on the number line that correspond to $\frac{1}{6}$, $\frac{2}{6}$, $\frac{3}{6}$, $\frac{4}{6}$, and $\frac{5}{6}$.

   ![Number line]

   b. Carefully cut out a strip of paper that has a length of $\frac{5}{6}$.
      i. Bring the ends of the strip together to fold the strip of paper in half. How long is half of the strip? Use your strip to mark this point on the number line.

      ii. What two numbers can you multiply to find the length of half the strip? Write an equation to show this.

   c. Unfold your paper strip so that you start with $\frac{5}{6}$ again. Now fold the strip of paper in half and then in half again.
      i. How long is half of half of the strip? Use your strip to mark this point on the number line.

      ii. What numbers can you multiply to find the length of half the strip? Write an equation to show this.

3. Example: **Solution** *(DOK 1)*
Chavone is remodeling her bathroom. She plans to cover the bathroom floor with tiles that are each 1 square foot. Her bathroom is $5 \frac{3}{4}$ feet wide and $8 \frac{1}{4}$ feet long.

How many tiles will she need to cover the floor? Give an exact answer that includes the fractions of a tile she will need. Each unit square has been broken into sixteenths to allow precise measurements. Use the figure below to illustrate your answer.

![Grid of tiles]

4. Example: Solution (DOK 3)

Alex, Bryan, and Cynthia are about to eat lunch, and they have two sandwiches to share.

a. Draw a picture to show how they could equally share the sandwiches. How much of a sandwich does each person get?

b. Write an equation involving addition to show how together these parts make up the 2 sandwiches. Explain how the equation you wrote represents this situation.

c. Write an equation involving multiplication to show how all the parts make up the 2 sandwiches. Explain how the equation you wrote represents this situation.

d. Write an equation using multiplication to show the fraction of a sandwich each student gets. Explain how the equation you wrote represents this situation.

e. Write an equation using division to show the fraction of a sandwich each student gets. Explain how the equation you wrote represents this situation.

5. Example: Solution (DOK 3)
The diagram below represents one whole.

Part One

Write a multiplication story that could be solved using the diagram with its two types of shading. Explain how your story context relates to the diagram provided.

Part Two

Write the equation that represents this situation. Explain how your equation relates to the diagram provided. Why is the diagram a good tool to use to solve this particular story context?

6. Example: Solution (DOK 2)

The 5th graders want to raise money for their overnight camping trip by selling cornbread during the school Chili Cook-Off contest. All the pans of cornbread are square. A pan of cornbread costs $12. The customers can buy any fractional part of a pan of cornbread and pay that fraction of $12. For example, $\frac{5}{8}$ of a full pan costs $\frac{5}{8}$ of $12.

a. Mrs. Farmer buys cornbread from a pan that is $\frac{1}{3}$ full. She buys $\frac{1}{3}$ of the remaining cornbread in the pan.

• What fraction of the whole pan of cornbread does she buy? Use objects and/or a diagram to show how much of the pan of cornbread she buys.

• What does she pay for the cornbread she bought? Use objects and/or a diagram to show how much pays.

b. The next customer is the school principal. He buys cornbread from a different pan that is $\frac{1}{2}$ full. He buys $\frac{3}{4}$ of the remaining cornbread in the pan.

• What fraction of the whole pan of cornbread does he buy? Use a diagram to show how much of the pan of cornbread he buys.

• What does he pay for the cornbread he bought? Use a diagram to show how much he will pay for his part of the pan.

• What would be the cost of the cornbread the principal bought if the price of the entire pan changed to:

7. Example: Solution (DOK 2)
1/4 mile Track

1 lap = 1/4 mile

Part One

Mrs. Gray gave a homework assignment with a fraction problem:

Will ran $1 \frac{3}{4}$ laps of a $\frac{3}{4}$ mile track. How far, in miles, did Will run? Jenna and Steve worked together on solving the problem. Jenna said that Will ran about $\frac{3}{4}$ mile because $1 \frac{3}{4} \times \frac{3}{4}$ is equal to about $\frac{3}{4}$. Steve answered that Will must have run more than $\frac{3}{4}$ mile because when you multiply, the product is always larger than the factors and $\frac{3}{4}$ is not larger than $\frac{3}{4}$.

a. Solve the problem. How far, in miles, did Will run?

b. Is Jenna or Steve correct? Explain your reasoning using words, numbers, and/or pictures.

Part Two

Steve and Jenna continued to work on their homework. The next problems were:

$$\frac{1}{3} \times 5 = \_\_\_\_\_\_$$

$$\frac{1}{2} \times 2\frac{2}{3} = \_\_\_\_\_\_$$

Steve said to Jenna, “Now I get it! When you multiply, the product is always bigger than one of the factors. In the first problem, $\frac{1}{3} \times 5$ equals $\frac{5}{3}$ which is bigger than $\frac{1}{3}$, In the second problem $\frac{1}{2} \times 2\frac{2}{3}$ equals $1\frac{1}{3}$ which is bigger than $\frac{1}{3}$.”

c. Is Steve’s reasoning correct? Does his rule that the product is always bigger than one of the factors always work?

d. Give at least two examples to prove that Steve is correct or incorrect.

8. Example: Solution (DOK 2)
The members of a cross country team like to continue training on their own during the summer. Nero ran 1 1/2 miles one day

a. Lily ran 3 times as far as Nero. How far did Lily run?

b. Jorge ran 3/4 times as far as Nero. How far did Jorge run?

c. Belinda ran 2 1/3 times as far as Nero. How far did Belinda run?

For each question above, show your reasoning with a diagram or a number line. Write a multiplication equation that represents the situation.

9. Example: Solution (DOK 3)

Part 1:

There are two design proposals for a new rectangular park in town.

- In design one, 2/3 of the area of the park is going to be a rectangular grass area and 1/2 of the grass area will be a rectangular soccer field.
- In design two, only 1/2 of the park is going to be a rectangular grass area and 3/4 of the grass area will be a rectangular soccer field.

Which design (one or two) will have a bigger soccer field? Explain your answer. Draw a diagram that can be used to compare the size of the soccer field in the two designs. Label the values 1/2 and 3/4 on the diagram.

Part 2:

Presley and Julia are cutting 1 ft. square poster board to make a sign for the new park. Presley cut her poster so that the length of the top and bottom are 1/2 ft and the length of the sides are 3/4 ft. Julia cut her poster so that the lengths of the top and bottom are 3/4 ft and the length of the sides are 1/2 ft.

Draw a diagram of each poster board. Label the values on the diagram.

How are their poster boards similar and different? Justify your reasoning.

10. Example: Look at the equation. (DOK 1)

\[
\frac{2}{3} \times \frac{2}{?} = n
\]

Sarah claims that for any fraction multiplied by 2/3, n will be less than 2/3.

To convince Sarah that this statement is only sometimes true:

Part A: Write one number in each box so the product, n, is less than 2/3.

\[
\frac{2}{3} \times \frac{2}{3} = n
\]

Part B: Write one number in each box so the product, n, is not less than 2/3.
\[
\frac{2}{3} \times ____ = n
\]

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11. Example: Select all expressions that are equal to \( \frac{1}{4} \). (DOK 1)
   a. \( 26 \times \frac{1}{8} \)
   b. \( 2 \frac{1}{8} \times 2 \)
   c. \( 4 \times 13 \)
   d. \( \frac{1}{4} \times 3 \)
   e. \( 13 \frac{1}{4} \)

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12. Example: Lola has 4 orange juice containers. Each container is \( \frac{5}{8} \) full. (DOK 1)
   Lola claims to have a total of \( 2 \frac{1}{2} \) gallons of orange juice in the 4 containers.
   Which of these statements must be true in order for Lola’s claim to be correct?
13. Example: Write one number in each box to create a fraction that correctly completes each statement.

\[
\begin{align*}
4 \times \square &< 4 \\
4 \times \square &= 4 \\
4 \times \square &> 4
\end{align*}
\]

14. Example: Use this rectangle to solve the problem.
What is the area, in square centimeters, of the rectangle?

i. $32 \frac{1}{4}$

ii. $32 \frac{1}{2}$

iii. $32 \frac{1}{2}$

iv. $38 \frac{1}{2}$

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14. Example: Look at the fraction model shown.

The shaded area represents $\frac{3}{2}$. Draw rectangles the size of A, B, C, and D in the answer space to construct a model that represents $3 \times \frac{3}{2}$. Label your rectangles you draw.
15. Example: Which fraction model best represents $4 \times \frac{2}{3}$? (DOK 1)

![Fraction Models]

5. Interpret multiplication as scaling (resizing), by:
   a. Comparing the size of a product to the size of one factor on the basis of the size of the other factor, without performing the indicated multiplication.
   b. Explaining why multiplying a given number by a fraction greater than 1 results in a product greater than the given number (recognizing multiplication by whole numbers greater than 1 as a familiar case); explaining why multiplying a given number by a fraction less than 1 results in a product smaller than the given number; and relating the principle of fraction equivalence $\frac{a}{b} = \frac{(n\times a)}{(n\times b)}$ to the effect of multiplying $\frac{a}{b}$ by 1. (5.NF.B.5) (DOK 1, 2, 3)

1. Example: Solution (DOK 1)
   Curt and Ian both ran a mile. Curt's time was \( \frac{8}{9} \) Ian's time. Who ran faster? Explain and draw a picture.

2. Example: Solution (DOK 3)
Your classmate Ellen says,

*When you multiply by a number, you will always get a bigger answer. Look, I can show you.*

Start with 9,

- Multiply by \( \frac{5}{3} \):
  
  \[ 9 \times \frac{5}{3} = \frac{45}{3} = 15 \]

The answer is 15, and 15 is bigger than 9.

It even works for fractions.

Start with \( \frac{1}{2} \),

- Multiply by 4:
  
  \[ \frac{1}{2} \times 4 = \frac{4}{2} = 2 \]

The answer is 2, and 2 is bigger than \( \frac{1}{2} \).

Ellen's calculations are correct, but her rule does not always work.

For what numbers will Ellen's rule work? For what numbers will Ellen's rule not work? Explain and give examples.

3. **Example:** **Solution** (DOK 3)

   The students in Raul's class were growing grass seedlings in different conditions for a science project. He noticed that Pablo's seedlings were \( 1 \frac{1}{2} \) times as tall as his own seedlings. He also saw that Celina's seedlings were \( \frac{3}{4} \) as tall as his own. Which of the seedlings shown below must belong to which student? Explain your reasoning.

![Seedlings Image]

4. **Example:** **Solution** (DOK 1)

   Cai, Mark, and Jen were raising money for a school trip.

   - Cai collected \( 2 \frac{1}{2} \) times as much as Mark.
   - Mark collected \( \frac{2}{3} \) as much as Jen.

   Who collected the most? Who collected the least? Explain.

5. **Example:** **Solution** (DOK 1)
Luke had a calculator that will only display numbers less than or equal to 999,999,999. Which of the following products will his calculator display? Explain.

a. $792 \times 999,999,999$

b. $\frac{1}{2} \times 999,999,999$

c. $\frac{15}{4} \times 999,999,999$

d. $0.67 \times 999,999,999$

6. Example: **Solution** (DOK 2)

Decide which number is greater without multiplying.

a. $817\text{ or } 235 \times 817$

b. $99\text{ or } \frac{1}{4} \times 99$

c. $\frac{51}{100}\text{ or } \frac{51}{100} \times 301$

d. $\frac{13}{90}\text{ or } \frac{2}{3} \times \frac{13}{90}$

e. $\frac{101}{102}\text{ or } \frac{101}{102} \times \frac{101}{102}$

f. $\frac{99}{5}\text{ or } \frac{99}{5} \times \frac{1}{2}$

g. $\frac{8}{21} \times 40\text{ or } \frac{28}{21} \times 40$

h. $\frac{8}{3} \times \frac{5}{7}\text{ or } \frac{8}{3} \times \frac{9}{4}$

7. Example: **Solution** (DOK 2)
The Burj Khalifa (Dubai) is about \(2\frac{3}{4}\) times as tall as the Eiffel Tower (Paris). The Eiffel Tower is about \(\frac{3}{4}\) as tall as the Willis Tower (Chicago).

a. Which of these buildings is the tallest? Which is the shortest? Explain.

b. Draw pictures to illustrate.

8. Example: Solution (DOK 2)

1/4 mile Track

1 lap = 1/4 mile

Part One

Mrs. Gray gave a homework assignment with a fraction problem:

Will ran \(1\frac{3}{4}\) laps of a \(\frac{1}{4}\) mile track. How far, in miles, did Will run?

Jenna and Steve worked together on solving the problem. Jenna said that Will ran about \(\frac{3}{4}\) mile because \(1\frac{3}{4} \times \frac{1}{4}\) is equal to about \(\frac{3}{4}\). Steve answered that Will must have run more than \(\frac{3}{4}\) mile because when you multiply, the product is always larger than the factors and \(\frac{3}{4}\) is not larger than \(1\frac{3}{4}\).

a. Solve the problem. How far, in miles, did Will run?

b. Is Jenna or Steve correct? Explain your reasoning using words, numbers, and/or pictures.

Part Two

Steve and Jenna continued to work on their homework. The next problems were:

\[
\begin{align*}
\frac{1}{3} \times 5 &= \_ \\
\frac{1}{2} \times 2\frac{2}{3} &= \_ 
\end{align*}
\]

Steve said to Jenna, “Now I get it! When you multiply, the product is always bigger than one of the factors. In the first problem, \(\frac{1}{3} \times 5\) equals \(\frac{5}{3}\), which is bigger than \(\frac{1}{3}\). In the second problem \(\frac{1}{2} \times 2\frac{2}{3}\) equals \(1\frac{1}{3}\), which is bigger than \(\frac{1}{2}\).”

c. Is Steve’s reasoning correct? Does his rule that the product is always bigger than one of the factors always work?

d. Give at least two examples to prove that Steve is correct or incorrect.

9. Example: Solution (DOK 2)
The fifth grade teachers are in charge of planning the annual Davis Elementary Fun Run. The teachers decide that each adult should run \( \frac{2}{3} \) as far as each student in grade 5 and each student in grade 1 should run \( \frac{3}{4} \) as far as each student in grade 5.

a. Who has to run the longest distance? Who has to run the shortest distance? Explain your reasoning.

b. The fifth grade students decide that they should each run four laps around the track. How many laps should each adult and each first grade student run?

c. Peyton, a fifth grader calculates that he will run a \( \frac{1}{2} \) mile. Write two multiplication equations involving \( \frac{1}{2} \) one that shows how many miles each adult will run and one that shows how many miles each first grade student will run.

d. When Peyton showed the adults his calculations, some of them were confused. Some of the adults thought multiplication always makes a number larger, for example \( 2 \times \frac{1}{5} \) is bigger than 5. When calculating the distance the first graders ran, Peyton used multiplication but got a smaller number. Explain why the product of 5 and another number is not always greater than 5, and write an example to help the adults understand.

e. Presley, another fifth grade student, wanted to write the distance she ran in eights. She noticed that you could write this equation: \( \frac{4}{3} \times \frac{3}{4} = \frac{3}{4} \) miles. Explain why in this case multiplying by \( \frac{1}{2} \) results in a product that is neither larger nor smaller than \( \frac{3}{4} \).

10. Example: Write a value for \( b \) that makes this statement true: \( 5 \times b \) is less than 5, but greater than 0.

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11. Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem. (5.NF.B.6) [DOK 1,2]

a. Example: Solution (DOK 1)
   The distance between Rosa’s house and her school is \( \frac{3}{4} \) mile. She ran \( \frac{1}{3} \) of the way to school. How many miles did she run?

b. Example: Solution (DOK 1)
   Alisa had \( \frac{3}{2} \) a liter of juice in a bottle. She drank \( \frac{3}{4} \) of the juice that was in the bottle. How many liters of juice did she drink?

c. Example: Solution (DOK 1)
   Kendra is making \( \frac{1}{2} \) of a recipe. The full recipe calls for \( 3 \frac{1}{4} \) cups of flour. How many cups of flour should Kendra use?

d. Example: Solution (DOK 2)
A recipe for chocolate chip cookies makes 4 dozen cookies and calls for the following ingredients:

- 1 1/2 C margarine
- 1 3/4 C sugar
- 2 t vanilla
- 3 1/4 C flour
- 1 t baking powder
- 1/4 t salt
- 8 oz chocolate chips

ea. How much of each ingredient is needed to make 3 recipes?

b. How much of each ingredient is needed to make 3/4 of a recipe?

e. Example: Solution (DOK 2)

Some of the problems below can be solved by multiplying \( \frac{1}{8} \times \frac{2}{3} \), while others need a different operation. Select the ones that can be solved by multiplying these two numbers. For the remaining, tell what operation is appropriate. In all cases, solve the problem (if possible) and include appropriate units in the answer.

a. Two-fifths of the students in Anya's fifth grade class are girls. One-eighth of the girls wear glasses. What fraction of Anya's class consists of girls who wear glasses?

b. A farm is in the shape of a rectangle \( \frac{1}{5} \) of a mile long and \( \frac{2}{5} \) of a mile wide. What is the area of the farm?

c. There is \( \frac{2}{5} \) of a pizza left. If Jamie eats another \( \frac{1}{3} \) of the original whole pizza, what fraction of the original pizza is left over?

d. In Sam's fifth grade class, \( \frac{1}{3} \) of the students are boys. Of those boys, \( \frac{2}{3} \) have red hair. What fraction of the class is red-haired boys?

e. Only \( \frac{3}{20} \) of the guests at the party wore both red and green. If \( \frac{1}{3} \) of the guests wore red, what fraction of the guests who wore red also wore green?

f. Alex was planting a garden. He planted \( \frac{3}{5} \) of the garden with potatoes and \( \frac{1}{4} \) of the garden with lettuce. What fraction of the garden is planted with potatoes or lettuce?
g. At the start of the trip, the gas tank on the car was $\frac{3}{4}$ full. If the trip used $\frac{1}{4}$ of the remaining gas, what fraction of a tank of gas is left at the end of the trip?

h. On Monday, $\frac{1}{3}$ of the students in Mr. Brown's class were absent from school. The nurse told Mr. Brown that $\frac{2}{3}$ of those students who were absent had the flu. What fraction of the absent students had the flu?

i. Of the children at Molly's daycare, $\frac{1}{2}$ are boys and $\frac{2}{5}$ of the boys are under 1 year old. How many boys at the daycare are under one year old?

j. The track at school is $\frac{3}{5}$ of a mile long. If Jason has run $\frac{1}{4}$ of the way around the track, what fraction of a mile has he run?

f. Example: **Solution** (DOK 2)

The Burj Khalifa (Dubai) is about $2 \frac{1}{2}$ times as tall as the Eiffel Tower (Paris). The Eiffel Tower is about $\frac{8}{9}$ as tall as the Willis Tower (Chicago).

a. Which of these buildings is the tallest? Which is the shortest? Explain.

b. Draw pictures to illustrate.

g. Example: **Solution** (DOK 2)

Some of the problems below can be solved by multiplying $\frac{1}{3} \times \frac{2}{5}$, while others need a different operation. Select the ones that can be solved by multiplying these two numbers. For the remaining, tell what operation is appropriate. In all cases, solve the problem (if possible) and include appropriate units in the answer.

a. Two-fifths of the students in Anya's fifth grade class are girls. One-eighth of the girls wear glasses. What fraction of Anya's class consists of girls who wear glasses?

b. A farm is in the shape of a rectangle $\frac{1}{5}$ of a mile long and $\frac{3}{8}$ of a mile wide. What is the area of the farm?

c. A pizza is cut into 8 slices. There is $\frac{2}{5}$ of the pizza left. If Jamie eats another slice, $\frac{1}{8}$ of the original whole pizza, what fraction of the original pizza is left over?

d. In Sam's fifth grade class, $\frac{1}{4}$ of the students are boys. Of those boys, $\frac{2}{5}$ have red hair. What fraction of the class is red-haired boys.

e. Alex was planting a garden. He planted $\frac{2}{7}$ of the garden with potatoes and $\frac{2}{3}$ of the garden with lettuce. What fraction of the garden is planted with potatoes or lettuce?

f. The track at school is $\frac{3}{5}$ of a mile long. If Jason has run $\frac{1}{4}$ of the way around the track, what fraction of a mile has he run?

h. Example: **Solution** (DOK 2)
Part 1:

There are two design proposals for a new rectangular park in town.

- In design one, \( \frac{3}{4} \) of the area of the park is going to be a rectangular grass area and \( \frac{1}{2} \) of the grass area will be a rectangular soccer field.
- In design two, only \( \frac{1}{2} \) of the park is going to be a rectangular grass area and \( \frac{3}{4} \) of the grass area will be a rectangular soccer field.

Which design (one or two) will have a bigger soccer field? Explain your answer. Draw a diagram that can be used to compare the size of the soccer field in the two designs. Label the values \( \frac{1}{2} \) and \( \frac{3}{4} \) on the diagram.

Part 2:

Presley and Julia are cutting 1 ft. square poster board to make a sign for the new park. Presley cut her poster so that the length of the top and bottom are \( \frac{3}{4} \) ft and the length of the sides are \( \frac{2}{3} \) ft. Julia cut her poster so that the lengths of the top and bottom are \( \frac{3}{4} \) ft and the length of the sides are \( \frac{1}{2} \) ft.

Draw a diagram of each poster board. Label the values on the diagram. How are their poster boards similar and different? Justify your reasoning.

12. Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions.\(^1\)
   
a. Interpret division of a unit fraction by a non-zero whole number, and compute such quotients. For example, create a story context for \( \frac{1}{3} \div 4 \), and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that \( \frac{1}{3} \div 4 = \frac{1}{12} \) because \( \frac{1}{12} \times 4 = \frac{1}{3} \).

b. Interpret division of a whole number by a unit fraction, and compute such quotients. For example, create a story context for \( 4 \div \frac{1}{5} \), and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that \( 4 \div \frac{1}{5} = 20 \) because \( 20 \times \frac{1}{5} = 4 \).

c. Solve real world problems involving division of unit fractions by non-zero whole numbers and division of whole numbers by unit fractions, e.g., by using visual fraction models and equations to represent the problem. For example, how much chocolate will each person get if 3 people share 1/2 lb of chocolate equally? How many 1/3-cup servings are in 2 cups of raisins? (S.NF.B.7) (DOK 1,2)
   
   1. Example: Solution (DOK 2)

\(^1\) Students able to multiply fractions in general can develop strategies to divide fractions in general, by reasoning about the relationship between multiplication and division. But division of a fraction by a fraction is not a requirement at this grade.
Solve the four problems below. Which of the following problems can be solved by finding $3 \div \frac{1}{3}$?

a. Shauna buys a three-foot-long sandwich for a party. She then cuts the sandwich into pieces, with each piece being $\frac{3}{4}$ foot long. How many pieces does she get?

b. Phil makes 3 quarts of soup for dinner. His family eats half of the soup for dinner. How many quarts of soup does Phil's family eat for dinner?

c. A pirate finds three pounds of gold. In order to protect his riches, he hides the gold in two treasure chests, with an equal amount of gold in each chest. How many pounds of gold are in each chest?

d. Leo used half of a bag of flour to make bread. If he used 3 cups of flour, how many cups were in the bag to start?

2. **Example:** **Solution** (DOK 2)

A package contains 4 cups of oatmeal. There is $\frac{1}{3}$ cup of oatmeal in each serving.

How many servings of oatmeal are there in the package? Explain. Draw a picture to illustrate your solution.

3. **Example:** **Solution** (DOK 2)

Alysha really wants to ride her favorite ride at the amusement park one more time before her parents pick her up at 2:30 pm. There is a very long line at this ride, which Alysha joins at 1:50 pm (point A in the diagram below). Alysha is nervously checking the time as she is moving forward in the line. By 2:03 she has made it to point B in line.

What is your best estimate for how long it will take Alysha to reach the front of the line? If the ride lasts 3 minutes, can she ride one more time before her parents arrive?

![Diagram of line](image)

4. **Example:** **Solution** (DOK 2)

Kulani is painting his room. He needs $\frac{1}{3}$ of a gallon to paint the whole room. What fraction of a gallon will he need for each of his 4 walls if he uses the same amount of paint on each? Explain your work and draw a picture to support your reasoning.

5. **Example:** **Solution** (DOK 2)

Avery and Megan are cutting paper to make origami stars. They need $\frac{3}{4}$ of a sheet of paper in order to make each star. If they have 6 sheets of paper, how many stars can they make? Explain your work and draw a picture to support your reasoning.

6. **Example:** **Solution** (DOK 2)

Julius has 4 blue marbles. If one third of Julius' marbles are blue, how many marbles does Julius have? Draw a diagram and explain.

7. **Example:** **Solution** (DOK 2)
a. How many cups of salad dressing will this recipe make? Write an equation to represent your thinking. Assume that the herbs and salt do not change the amount of dressing.

b. If this recipe makes 6 servings, how much dressing would there be in one serving? Write a number sentence to represent your thinking.

8. Example: Solution (DOK 2)

Carolina is making her special banana pudding recipe. She is looking for her cup measure, but can only find her quarter cup measure.

a. How many quarter cups does she need for the sour cream? Draw a picture to illustrate your solution, and write an equation that represents the situation.

b. How many quarter cups does she need for the milk? Draw a picture to illustrate your solution, and write an equation that represents the situation.

c. Carolina does not remember in what order she added the ingredients but the last ingredient added required 12 quarter cups. What was the last ingredient Carolina added to the pudding? Draw a picture to illustrate your solution, and write an equation that represents the situation.

9. Example: Ryan has \( \frac{1}{2} \) pound of chocolate. He divides it into 4 equal portions.

Write the amount of chocolate, in pounds, in each portion.

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Measurement and Data             5.MD

Convert like measurement units within a given measurement system. (5.MD.A)

1. Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems. (5.MD.A.1) (DOK 1,2)
   a. Example: Solution (DOK 2)
      i. Five brothers are going to take turns watching their family’s new puppy. How much time will each brother spend watching the puppy in a single day if they all watch him for an equal length of time? Write your answer
         i. Using only hours,
         ii. Using a whole number of hours and a whole number of minutes, and
         iii. Using only minutes.
   b. Mrs. Hinojosa had 75 feet of ribbon. If each of the 18 students in her class gets an equal length of ribbon, how long will each piece be? Write your answer
         i. Using only feet,
         ii. Using a whole number of feet and a whole number of inches, and
         iii. Using only inches.
   c. Wesley walked 11 miles in 4 hours. If he walked the same distance every hour, how far did he walk in one hour? Write your answer
      i. Using only miles,
      ii. Using a whole number of miles and a whole number of feet, and
      iii. Using only feet.
   d. Example: Solution (DOK 2)
      What time was it 2011 minutes after the beginning of January 1, 2011?
   e. Example: Susan has 4 gallons of juice. How many cups of juice does she have? 
      Cups=______

<table>
<thead>
<tr>
<th>Item</th>
<th>Claim</th>
<th>Domain</th>
<th>Target</th>
<th>DOK</th>
<th>CONTENT</th>
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<td>G</td>
<td>1</td>
<td>5.MD.A.1</td>
<td>N/A</td>
<td>64</td>
</tr>
</tbody>
</table>

d. Example: Use this pentagon to solve the problem. Write the perimeter, in centimeters, of the pentagon.
e. Example: (Former NAEP Question) (DOK 2)

A company from Japan was doing business in the United States. In 2007 it had an annual income of $1,000,000 and annual expenses of $800,000. The formula below shows the relationship between income, expenses, and profit.

\[
\text{Income} = \text{Expenses} + \text{Profit}
\]

About how much was this company’s profit, in Japanese yen, in 2007?

(In 2007, 1 United States dollar was approximately equal to 127 yen.)

A. 1,600 yen  
B. 200,000 yen  
C. 2,500,000 yen  
D. 18,000,000 yen  
E. 25,000,000 yen

Answer: E. 25,000,000 yen
f. Example: (Former NAEP question) (DOK 1)

The table below shows the distance of each planet from the Sun, to the nearest million kilometers.

<table>
<thead>
<tr>
<th>Planet</th>
<th>Distance from Sun (in millions of kilometers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>58</td>
</tr>
<tr>
<td>Venus</td>
<td>108</td>
</tr>
<tr>
<td>Earth</td>
<td>150</td>
</tr>
<tr>
<td>Mars</td>
<td>228</td>
</tr>
<tr>
<td>Jupiter</td>
<td>778</td>
</tr>
<tr>
<td>Saturn</td>
<td>1,427</td>
</tr>
<tr>
<td>Uranus</td>
<td>2,871</td>
</tr>
<tr>
<td>Neptune</td>
<td>4,497</td>
</tr>
<tr>
<td>Pluto</td>
<td>5,914</td>
</tr>
</tbody>
</table>

One astronomical unit (AU) is defined as the distance between Earth and the Sun (1 AU ≈ 150 million kilometers). To the nearest whole number, how many astronomical units is Pluto from the Sun?

A. 6,064 AU  
B. 5,914 AU  
C. 5,764 AU  
D. 150 AU  
E. 39 AU

Answer: E. 39 AU

g. Example: (Former NAEP question) (DOK 1)

How many 200-milliliter servings can be poured from a pitcher that contains 2 liters of juice?

A. 20  
B. 15  
C. 10  
D. 5  
E. 1

Answer: C. 10

h. Example: (Former NAEP question) (DOK 1)

Which of the following containers has the greatest liquid capacity?

(1 gallon = 4 quarts = 8 pints = 128 ounces)

A. A 64-ounce orange juice container  
B. A 16-pint water jug  
C. A 5-quart punch bowl  
D. A 2-quart cola bottle  
E. A 1-gallon milk bottle

Answer: B. A 16 pint water jug

Represent and interpret data. (5.MD.B)

2. Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Use operations on fractions for this grade to solve problems involving information presented in line plots. For example, given different measurements of liquid in identical beakers, find the amount of liquid each beaker would contain if the total amount in all the beakers were redistributed equally. (5.MD.B.2) (DOK 1,2)

a. Example: Solution (DOK 2)
Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition. (5.MD.C)

**Example:** The bed of a truck is stacked with boxes of paper. The boxes are stacked 5 boxes deep by 4 boxes high by 4 boxes across, as shown in the picture.

- When the driver is in the **empty** truck, the mass is 2948.35 kilograms.
- The mass of 1 box of paper is 22.5 kilograms.
- The driver delivers some of the boxes of paper at his first stop.
- The truck has to drive over a bridge on the way to the next stop.
- Trucks with a mass greater than 4700 kilograms are **not** allowed to drive over the bridge.

Write the **minimum** number of boxes of paper the driver must deliver at the first stop to be allowed to drive over the bridge.

<table>
<thead>
<tr>
<th>Item</th>
<th>Claim</th>
<th>Domain</th>
<th>Target</th>
<th>DOK</th>
<th>CONTENT</th>
<th>MP</th>
<th>Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>#18</td>
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<td>MD, NBT</td>
<td>D</td>
<td>2</td>
<td>5.MD.C, 5.NBT.B.7</td>
<td>1, 2, 5, 6</td>
<td>3</td>
</tr>
</tbody>
</table>

3. Recognize volume as an attribute of solid figures and understand concepts of volume measurement.
a. A cube with side length 1 unit, called a "unit cube," is said to have "one cubic unit" of volume, and can be used to measure volume.
b. A solid figure which can be packed without gaps or overlaps using \( n \) unit cubes is said to have a volume of \( n \) cubic units. \((5.\text{MD}.\text{C}.3)\) \(\text{(DOK 1)}\)

1. Example: The rectangular prism shown has 4 layers with 6 cubes in each layer.

Write the volume, in cubic centimeters, of the rectangular prism.

<table>
<thead>
<tr>
<th>Item</th>
<th>Claim</th>
<th>Domain</th>
<th>Target</th>
<th>DOK</th>
<th>CONTENT</th>
<th>MP</th>
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</tr>
</thead>
<tbody>
<tr>
<td>#8</td>
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<td>MD</td>
<td>I</td>
<td>2</td>
<td>5.\text{MD}.\text{C}.4, 5.\text{MD}.\text{C}.3</td>
<td>N/A</td>
<td>24</td>
</tr>
</tbody>
</table>

4. Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units. \((5.\text{MD}.\text{C}.4)\) \(\text{(DOK 1,2)}\)

a. Example: The rectangular prism shown has 4 layers with 6 cubes in each layer.
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.

   c. Recognize volume as additive. Find volumes of solid figures composed of two non-overlapping right rectangular prisms by adding the volumes of the non-overlapping parts, applying this technique to solve real world problems.

---

<table>
<thead>
<tr>
<th>#8</th>
<th>1</th>
<th>MD</th>
<th>I</th>
<th>2</th>
<th>5.MD.C.4, 5.MD.C.3</th>
<th>N/A</th>
</tr>
</thead>
</table>

b. Example: [Former NAEP question] (DOK 2)

![Solid A](image1.png) ![Solid B](image2.png)

**How many more small cubes were used to make Solid A than Solid B?**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>4</td>
</tr>
<tr>
<td>C</td>
<td>6</td>
</tr>
<tr>
<td>D</td>
<td>7</td>
</tr>
</tbody>
</table>

Answer: B. 4
(5.MD.C.5) (DOK 1,2)

1. Example: Solution (DOK 2)
   Cari is the lead architect for the city's new aquarium. All of the tanks in the aquarium will be rectangular prisms where the side lengths are whole numbers.
   
a. Cari's first tank is 4 feet wide, 8 feet long and 5 feet high. How many cubic feet of water can her tank hold?

   ![Rectangular prism diagram]

   b. Cari knows that a certain species of fish needs at least 240 cubic feet of water in their tank. Create 3 separate tanks that hold exactly 240 cubic feet of water. (Ex: She could design a tank that is 10 feet wide, 4 feet long and 6 feet in height.)

   c. In the back of the aquarium, Cari realizes that the ceiling is only 10 feet high. She needs to create a tank that can hold exactly 100 cubic feet of water. Name one way that she could build a tank that is not taller than 10 feet.

2. Example: Solution (DOK 2)
   Make sure you have plenty of snap cubes. * Build a rectangular prism that is 2 cubes high, 3 cubes wide, and 5 cubes long. * We will say that the volume of one cube is 1 cubic unit. What is the volume of the rectangular prism? * The volume of the cube is $2 \times 3 \times 5$ cubic units. The expression

   $$2 \times (3 \times 5)$$

   can be interpreted as 2 groups with $3 \times 5$ cubes in each group. $3 \times 5$ can be interpreted as 3 groups with 5 cubes in each groups. How can you see the rectangular prism as being made of 2 groups with (3 groups of 5 cubes in each)? * Explain how you can see each of these products by looking at the rectangular prism in different ways:

   $$2 \times (5 \times 3)$$
   $$3 \times (2 \times 5)$$
   $$3 \times (5 \times 2)$$
   $$5 \times (2 \times 3)$$
   $$5 \times (3 \times 2)$$

3. Example: Solution (DOK 2)
Make sure you have plenty of snap cubes.

a. Build a rectangular prism that is 2 cubes on one side, 3 cubes on another, and 5 cubes on the third side.

b. We will say that the volume of one cube is 1 cubic unit. What is the volume of the rectangular prism?

c. Jenna said,

The rectangular prism is 2 cubes by 3 cubes by 5 cubes, so the volume of the prism is \(2 \times 3 \times 5\) cubic units.

Ari said,

I don’t know what \(2 \times 3 \times 5\) means. Do you multiply the 2 and 3 first

\[
2 \times 3 \times 5 = (2 \times 3) \times 5 \\
= 6 \times 5
\]

so you have 6 groups of 5, or do you multiply the 3 and the 5 first

\[
2 \times 3 \times 5 = 2 \times (3 \times 5) \\
= 2 \times 15
\]

so you have 2 groups of 15?

• Explain how you can see the rectangular prism as being made of 2 groups with 15 cubes in each.

• Explain how you can also see the rectangular prism as being made of 6 groups with 5 cubes in each.

d. Does it matter which numbers you multiply first when you want to find the volume of a rectangular prism?

4. Example: Solution (DOK 2)

Students will need two different color markers or crayons to complete this task.

John was finding the volume of this figure. He decided to break it apart into two separate rectangular prisms. John found the volume of the solid below using this expression: \((4 \times 4 \times 1) + (2 \times 4 \times 2)\).

Decompose the figure into two rectangular prisms and shade them in different colors to show one way John might have thought about it.

Phillis also broke this solid into two rectangular prisms, but she did it differently than John. She found the volume of the solid below using this expression: \((2 \times 4 \times 3) + (2 \times 4 \times 1)\).

Decompose the figure into two rectangular prisms and shade them in different colors to show one way Phillis might have thought about it.
5. Example: Brady started to fill the box shown with some unit cubes.

Write the total number of unit cubes needed to completely fill the box. Include the unit cubes already shown in your total.

<table>
<thead>
<tr>
<th>Item</th>
<th>Claim</th>
<th>Domain</th>
<th>Target</th>
<th>DOK</th>
<th>CONTENT</th>
<th>MP</th>
<th>Key</th>
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</thead>
<tbody>
<tr>
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<td>D</td>
<td>2</td>
<td>6.NS.B.3, 5.MD.C.5</td>
<td>6, 7</td>
<td></td>
</tr>
</tbody>
</table>

6. Example: (Former NAEP question) (DOK 2)

Sierra built the block tower with 1-foot cubes. How many cubes did she use?

A. 4
B. 6
C. 8
D. 10

Answer: D. 10
7. Example: (Former NAEP question) (DOK 2)

Mr. Elkins plans to buy a refrigerator. He can choose from five different refrigerators whose interior dimensions, in inches, are given below. Which refrigerator has the greatest capacity (volume)?

A. 42 x 34 x 30
B. 42 x 30 x 32
C. 42 x 28 x 32
D. 40 x 34 x 30
E. 40 x 30 x 28

Answer: A. 42 X 34 X 30

8. Example: The right rectangular prism shown has a length of 6 centimeters, width of 3 centimeters, and height of 4 centimeters.

![Prism Diagram]

Determine whether each equation can be used to find the volume \( V \) of this prism. Select Yes or No for each equation.

<table>
<thead>
<tr>
<th>Equation</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V = 18 \times 4 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V = (6 + 3) \times 4 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V = 6 \times 3 \times 4 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V = 9 \times 4 )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Example: Walter puts 1050 cubic inches of dirt into the tank shown. Shade in the number line to show the height of the dirt in the tank.
<table>
<thead>
<tr>
<th>Item</th>
<th>Claim</th>
<th>Domain</th>
<th>Target</th>
<th>DOK</th>
<th>CONTENT</th>
<th>MP</th>
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<td>2</td>
<td>5.MD.C.5</td>
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<td></td>
</tr>
</tbody>
</table>

![Diagram of a rectangular prism with dimensions 30 in x 7 in x 21 in.](image)
Graph points on the coordinate plane to solve real-world and mathematical problems. (5.G.A)

1. Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., x-axis and x-coordinate, y-axis and y-coordinate). (5.G.A.1) (DOK 1)

a. Example: Solution (DOK 2)

Materials

The students will need grid paper and colored pencils; some color for the ships and (for example) red for explosions on their ships and their enemy's ships. This is how they will keep track of what ordered pairs have been called.

Setup

Students begin by folding the grid paper in half. They need to draw coordinate axes on both the top half and the bottom half and label the x and y axes with the numbers 1–10 on each axis. The students will need to draw in 5 ships on ordered pairs and label the ordered pairs. They should draw:

- Two ships that are sitting on 2 ordered pairs,
- One ship that is sitting on 3 ordered pairs,
- One ship that is sitting on 4 ordered pairs, and
- One ship sitting on 5 ordered pairs.

Remind them the bottom half has their boats or (Navy) and the top half has their opponent's boats.

Actions

Students play in pairs sitting opposite each other and take turns calling out ordered pairs. Players should keep a list of the ordered pairs they call out written in \((x, y)\) form on a piece of paper that both players can see so there is no disagreement later on about what has been called (it is common for students to transpose the coordinates). Then they are to mark the ordered pair they call out on the top coordinate plane. They should mark in black if they missed and red if they hit their opponent's boat. On the bottom half of the grid paper they are to color black for the ordered pairs their opponent calls out and color red for the ordered pairs that hit their ship.

b. Example: Triangle ABC is graphed in the coordinate plane.
Which set of ordered pairs shows the coordinates of points A, B, C?

1. A (2,7), B (4,3), C (5,6)
2. A (2,7), B (5,6), C (4,3)
3. A (7,2), B (3,4), C (6,5)
4. A (7,2), B (4,3), C (5,6)

<table>
<thead>
<tr>
<th>Item</th>
<th>Claim</th>
<th>Domain</th>
<th>Target</th>
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<tbody>
<tr>
<td>#10</td>
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<td>J</td>
<td>1</td>
<td>5.G.A.1</td>
<td>N/A</td>
<td>A</td>
</tr>
</tbody>
</table>

c. Example: (Former NAEP question) (DOK 1)
On the grid below, plot the points that have coordinates (B, 1), (B, 3), and (D, 5).

Plot 3 more points on the grid so that when you connect all 6 points you will make a rectangle.

List the coordinates for the 3 new points. _______ _______ _______

Connect the 6 points to show your rectangle.
Answer: (B, 5), (D, 1), (D, 3)
Example: (Former NAEP question) (DOK 1)

The graph above shows lettered points in an \((x, y)\) coordinate system. Which lettered point has coordinates \((-3, 0)\)?

A. A
B. B
C. C
D. D
E. E
2. Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. *(5.G.A.2) (DOK 1,2)*

   a. Example: **Solution** (DOK 2)

   Greetings from the Kalahari Desert in South Africa! In this activity, you will learn a lot about the Kalahari's most playful residents: meerkats.

   a. The following ordered pairs show the height of a typical meerkat at different times during the first 20 months of life. Graph the corresponding points and see what you can discover about meerkats. Once you have graphed them all, connect the points in the order they are given to form a line graph.

   ![Graph of meerkat height](image)

   - See if you can graph these ordered pairs:
     - (0 months, 3 inches)
     - (2 months, 5 inches)
     - (4 months, 6 inches)
     - (6 months, 7 inches)
     - (8 months, 8 inches)
     - (10 months, 9 inches)
     - (12 months, 10 inches)
     - (14 months, 12 inches)
     - (16 months, 12 inches)
     - (18 months, 12 inches)
     - (20 months, 12 inches)

   b. What does the point (0 months, 3 inches) mean for a typical meerkat's height?

   c. How tall do you think a typical meerkat gets? Why?

   d. At what age do meerkats reach their full height? How do you know from this graph?

   e. If this graph were about a human instead of a meerkat, at what age do you think the height would stop getting larger?

   b. Example: The location of Mary's home is plotted on the coordinate grid. Read these clues about other places in Mary's town.
• The bank is located at (9, 1).
• The library is 6 blocks from the store.
• The store is 3 blocks from the park.
• The hospital is 5 blocks from the library.
• The park is 4 blocks from Mary’s home.

Write in the names of each place by the correct location on the coordinate grid.

Key

— represents 1 block

<table>
<thead>
<tr>
<th>Bank</th>
<th>Hospital</th>
<th>Library</th>
<th>Park</th>
<th>Store</th>
</tr>
</thead>
</table>

Home
<table>
<thead>
<tr>
<th>Item</th>
<th>Claim</th>
<th>Domain</th>
<th>Target</th>
<th>DOK</th>
<th>CONTENT</th>
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<td>G</td>
<td>F</td>
<td>3</td>
<td>5.G.A.2</td>
<td>1, 4</td>
<td></td>
</tr>
</tbody>
</table>

c. Example: [Former NAEP question](DOK 2)

The graph shows the total number of minutes it took Selena to do math problems.

![Graph showing homework time](image)

How many minutes did it take her to do 3 problems?

Answer: ________________ minutes

Selena continues to work at the same rate.

How many problems will she do in 40 minutes?

Answer: ________________ problems

Answer: 15 minutes, 8 problems

Classify two-dimensional figures into categories based on their properties. (5.G.B)
3. Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles. (5.G.B.3) (DOK 1,2)
   a. Example: Solution (DOK 2)
      Decide whether each of these statements is always, sometimes, or never true. If it is sometimes true, draw and describe a figure for which the statement is true and another figure for which the statement is not true.

      a. A rhombus is a square
      b. A triangle is a parallelogram
      c. A square is a parallelogram
      d. A square is a rhombus
      e. A parallelogram is a rectangle
      f. A trapezoid is a quadrilateral

   b. Example: All parallelograms have opposite sides that are equal in length and parallel. Determine whether each polygon shown is also a parallelogram. Select Yes or No for each polygon.

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Rectangle]</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>![Trapezoid]</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>![Rhombus]</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
c. Example: (Former NAEP question) (DOK 3)

Sara was asked to draw a parallelogram. She drew the figure below.

Is Sara's figure a parallelogram? Why or why not?

Answer: Yes, the opposites are parallel to each other

d. Example: (Former NAEP question) (DOK 2)

The degree measures of the angles of a rectangle are \(a, b, c,\) and \(d\). Which of the following must be true about the rectangle?

A. \(a + b + c = d\)
B. \(a + b + c + d = 90\)
C. \(a + b + c + d = 180\)
D. \(a + b + c + d = 270\)
E. \(a + b + c + d = 360\)

Answer: E.

4. Classify two-dimensional figures in a hierarchy based on properties. (5.G.B.4) (DOK 1,2)

a. Example: Solution (DOK 2)
Niko and Carlos are studying parallelograms and trapezoids. They agree that a parallelogram is a quadrilateral with two pairs of parallel sides. Niko says,

_A trapezoid has one pair of parallel sides and a parallelogram has two pairs of parallel sides. So a parallelogram is also a trapezoid._

Carlos says,

*No - a trapezoid can have only one pair of parallel sides.*

Niko says,

_That's not true. A trapezoid has at least one pair of parallel sides, but it can also have another._

a. With a partner, discuss the difference between Niko's definition and Carlos' definition for a trapezoid.

b. Some people use Niko's definition for a trapezoid, and some people use Carlos' definition. Which statements below go with Niko's definition? Which statements go with Carlos' definition?
   i. All parallelograms are trapezoids.
   ii. Some parallelograms are trapezoids.
   iii. No parallelograms are trapezoids.
   iv. All trapezoids are parallelograms.
   v. Some trapezoids are parallelograms.
   vi. No trapezoids are parallelograms.

c. Which picture represents the relationship between trapezoids and parallelograms for each definition?
   i. 
   ![Diagram of trapezoids and parallelograms relationship]

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ii. Example: Solution (DOK 2)

The picture below is called a Venn Diagram. Each circle (A, B, and C) contain shapes that all share at least one characteristic. Some shapes are contained in more than one circle because they share more than one characteristic. For example, shape 3 fits the rule for circles A and B, but not circle C. It lies within circles A and B, but not circle C.

a. What are the characteristics shared by shapes within circle A? Within circle B? Within circle C? Double check to make sure that any shapes that have that characteristic are contained within the circle and any shapes that don't lie outside of the circle.
b. Where would you place a rectangle that does not have four sides of the same length? Why?

c. Example: (Former NAEP question) (DOK 2)
   Nick has a square piece of paper. He draws the two diagonals of the square, finds the point where they intersect, and labels that point A. Then he folds each of the four corners of the paper onto point A. What geometric shape is produced?
   A. A square  
   B. A right triangle  
   C. An isosceles triangle  
   D. A pentagon  
   E. A hexagon

d. Example: (Former NAEP question) (DOK 1)

![Diagram of a right triangle]

What kind of triangle is shown above?
   A. Equilateral  
   B. Isosceles  
   C. Scalene  
   D. Acute  
   E. Obtuse

e. Example: (Former NAEP question) (DOK 2)

If a triangle is equilateral, which of the following must be true?
   A. Only two sides are equal.  
   B. All sides are equal.  
   C. All angles are right angles.  
   D. All angles have different degree measures.
Performance Task Example:

**COMMUNITY GARDEN**

Your class is going to plant vegetables in a section of the local community garden. The garden manager has provided an area to plant the vegetables as follows:

The total area for the class to plant vegetables will be a rectangle 40 feet long and 30 feet wide.

The class has decided to plant four rectangular sections of the class garden with vegetables according to this plan:

- 1/4 of the garden will be planted with carrots.
- 1/6 of the garden will be planted with potatoes.
- 1/8 of the garden will be planted with broccoli.
- 1/12 of the garden will be planted with corn.

In this task, you will analyze the class plan and determine an alternate plan that will help make the most use of the available area.

1. Using the connect line tool, draw rectangles on this model of the garden to represent the four rectangular sections for planting vegetables according to the class plan. The garden model is divided into 5 feet by 5 feet sections.
   - Use whole number side lengths.
   - Each square on the model represents 1 square foot.
   - Drag the correct label that shows the vegetable for each section.

   ![Garden Model](image)

   For this item, a full-credit response (1 point) includes
   - carrots: 10 x 30 rectangle; potatoes: 5 x 40 rectangle; broccoli: 5 x 30 rectangle; corn: 4 x 25 rectangle OR
   - any four areas that are correct.

   For this item, a no-credit response (0 points) includes none of the features of a full-credit response.

2. Think about the class plan for the garden plot. What fraction of the garden plot will be left over after the class plants their vegetables?

   For this item, a full-credit response (1 point) includes
   - \(\frac{3}{8}\) OR
   - any equivalent fraction.

   For this item, a no-credit response (0 points) includes none of the features of a full-credit response.

3.
Your class has decided to plant potatoes in the unused portion of the garden plot.

Part A
What total fraction of the class garden will be planted with potatoes? Remember that 1/6 of the garden is already planned for potatoes.
Enter your response in the first response box.

Part B
How many square feet of the class garden plot will be planted with potatoes?
Enter your response in the second response box.

For this item, a full-credit response (2 points) includes
\[
\frac{13}{24} \text{ AND } 650.
\]
For this item, a partial-credit response (1 point) includes
\[
\frac{13}{24} \text{ OR }
\]
• 650 or total square feet consistent with an error in Part A

For this item, a no-credit response (0 points) includes none of the features of a full- or partial-credit response.

4.
Using the new plan with more potatoes, write an equation to show that the total area of the class’s garden is used to grow vegetables. Make sure the equation shows that the sum of the areas, in square feet, of each section equals the total area of the class’s garden.

• Carrots
• Potatoes
• Broccoli
• Corn

For this item, a full-credit response (2 points) includes
• writing the correct sum: \[300 + 650 + 150 + 100\]
AND writing the correct sum as an equation.
For example,
\[300 + 650 + 150 + 100 = 1200\]

For this item, a partial-credit response (1 point) includes
• writing the correct sum without using an equation OR
• writing an incorrect sum, but using an equation.
For example,
\[300 + 650 + 150 + 100 \text{ OR } 200 + 300 + 600 = 1100\]

For this item, a no-credit response (0 points) includes none of the features of a full- or partial-credit response.