

# Exemplar Grade 8 Mathematics Test Questions



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# Introduction

This booklet explains ACT<sup>®</sup> Aspire<sup>®</sup> Grade 8 Mathematics test questions by presenting, with their answer keys, sample questions aligned to each reporting category on the test. A key includes the question's depth-of-knowledge (DOK) level,<sup>1</sup> an explanation of the task posed by each question, a thorough explanation of correct responses, ideas for improvement, and more. The exemplar test questions included here are representative of the range of content and types of questions found on the ACT Aspire Grade 8 Mathematics test. Educators can use this resource in several ways:

- Become familiar with ACT Aspire question types.
- See what typical questions in each ACT Aspire reporting category look like.
- Help reinforce or adjust teaching and learning objectives.
- Learn how ACT Aspire improvement idea statements can help students identify key skills they have not yet mastered.

ACT Aspire Mathematics tests provide a picture of the whole of a student's mathematical development, including a look at the concepts and skills new to the grade level as well as whether the student has continued to strengthen, integrate, and apply mathematics from earlier grades. These components are important in judging how a student is progressing and what next steps are appropriate.

## Reporting Categories

The following ACT Aspire reporting categories help to provide this picture.

### Grade Level Progress

The Grade Level Progress reporting category represents a student's achievement related to the mathematical topics new to the grade. To allow for an analysis of student strengths, the category also includes a reporting category for each of the grade-level domains that constitute Grade Level Progress for that grade.

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<sup>1</sup> Norman L. Webb, "Depth-of-Knowledge Levels for Four Content Areas," last modified March 28, 2002, <http://facstaff.wcer.wisc.edu/normw/All%20content%20areas%20%20DOK%20levels%2032802.doc>.

## Integrating Essential Skills

The Integrating Essential Skills reporting category looks at the mathematical growth of the student with topics learned in previous grades. This mathematics should not be static, but should be strengthened as the student progresses through the grades. Students should integrate and become more fluent in these topics, using them flexibly as needed to solve problems, give explanations, and accomplish tasks of greater complexity that reflect grade-level expectations for mathematical practice.

Together, the Grade Level Progress and Integrating Essential Skills categories make up the entirety of the ACT Aspire Mathematics test. Two other reporting categories, Modeling and Justification and Explanation, pull out information that crosses the other reporting categories.

## Modeling

The Modeling reporting category highlights questions that assess understanding of mathematical models and their creation, interpretation, evaluation, and improvement. Modeling is closely tied to problem solving, and because models are frequently used to teach mathematics—especially in the early grades—modeling is also closely tied to learning mathematics. Modeling expectations increase from one grade to the next. To ensure that the Modeling reporting category provides a better indication of being on track, some modeling skills are a part of the reporting category in lower grades but not in upper grades.

## Justification and Explanation

The Justification and Explanation (JE) category focuses on giving reasons for why things work as they do, where students create a mathematical argument to justify. The evidence is collected through constructed-response tasks designed around a progression of justification skills connecting Grades 3 and up.

## Structure of the Mathematics Test

The structure of the ACT Aspire Mathematics test is the same from Grade 3 through early high school (Grades 9 and 10), assessing new topics for the grade and whether students continue to strengthen their mathematical core. (For the Early High School test, Grade 8 topics are included in the Grade Level Progress component to keep together formal algebra, functions, and geometry topics. This makes Grade Level Progress and its subcategories more coherent.) Within this structure of content comes a level of rigor represented in part by a distribution of depth of knowledge through Webb's level 3. The Integrating Essential Skills component includes only DOK level 2 and level 3 because that component is about assessing how well students have continued to strengthen their mathematical core. Across all parts of the test, students can apply Mathematical Practices to help them demonstrate their mathematical achievement.

Mathematical justification is a way of knowing. In theory, students will be able to learn new mathematics more reliably if they have a strong framework to build upon. Mathematical justification is glue for that framework. The Common Core State Standards for Mathematics (CCSSM) recognizes this in its Mathematical Practice 3 (MP3): “Create viable arguments and critique the reasoning of others.” The ACT Aspire Mathematics test focuses attention on student justification.

Students respond to JE tasks with a grade-level-appropriate mathematical argument. These tasks utilize a constructed-response format, allowing students flexibility in the way they shape their arguments. Each response is evaluated on the basis of demonstrated evidence of particular skills associated with mathematical justification. These JE skills include stating relevant properties and definitions that support the justification, constructing an argument that includes reasons for claims, and demonstrating indirect proof or command of counterexample.

The JE skills identified in table 1 are arranged in a progression from Grade 3 through EHS. At each grade, the JE skills are divided into three levels. Trained scorers weigh evidence and then make an overall determination about the evidence for or against each skill level. Demonstrating JE skills at one level is evidence of having learned the skills in previous levels. In addition to looking at the JE skills, each response is rated according to how successful the student was in completing the task assigned; this is the Progress rating. A full-credit response shows evidence of the required level of JE skills needed to solve the problem and applies these skills to complete the task.

For each of the JE tasks, evidence for and against each of the JE levels is combined with the Progress rating and mapped to a 0–4 scale. These task scores contribute to the JE reporting category and to the total Mathematics score. Some of the tasks contribute to the Grade Level Progress reporting category, and the others contribute to the Integrating Essential Skills reporting category.

Level 1 JE skills are those where students should have a fluent command, and Level 2 JE skills are those most closely aligned with grade-level focus. Level 3 JE skills are more advanced. As the research base increases for this progression, the list will grow and become more refined. Note that there are two JE statements for evidence of misconceptions. These are marked with asterisks in table 1.

As students progress from grade to grade, expectations increase according to which JE skill belongs to which level. Some level 3 JE skills will become level 2, and some level 2 will become level 1.

**Table 1. Justification and Explanation Skills Progression**

Justification statement	JE level at grade:				
	3–4	5	6–7	8	10
<b>EXA</b> Provide an example.	1	1	1	1	1
<b>DEF</b> State a definition, theorem, formula, or axiom.	1	1	1	1	1
<b>PRT</b> State a property or classification of an object.	1	1	1	1	1
<b>REL</b> State a relationship between two or more objects.	1	1	1	1	1
<b>PRO1</b> State one or more steps in a procedure.	1	1	1	1	1
<b>VIS1</b> Provide a visual representation.	1	1	1	1	1
<b>CMP1</b> Provide a computation.	1	1	1	1	1
<b>LFD1</b> Use a Specific Statement to draw a Conclusion or Provide Specific Support for a Statement.	1	1	1	1	1
<b>CMP2</b> Use a computation to Support a Statement or Conclusion.	2	1	1	1	1
<b>PAT1</b> Generate a sequence from a rule OR explain a pattern using words, algebraic expressions, or numeric operations.	2	1	1	1	1
<b>LFD2</b> Use two or more Specific Statements to draw a Conclusion.	2	1	1	1	1
<b>ERR1</b> Indicate an error occurred.	2	1	1	1	1
<b>PRO2</b> Explain why a step in a procedure is necessary.	2	2	2	1	1
<b>CON1</b> Make a conditional statement (e.g. If-Then, When-Then, etc.).	2	2	2	1	1
<b>VIS2</b> Draw and label a visual representation that illustrates a mathematical concept, property, or relationship.	2	2	2	1	1
<b>PAT2</b> Use a pattern or sequence to support a Statement or Conclusion.	2	2	2	1	1
<b>CNE1</b> Provide a counterexample of a conditional statement.	2	2	2	2	2
<b>LFD3</b> Use a General Statement to draw a Conclusion or Provide General Support for a Statement.	2	2	2	2	2
<b>LFD4</b> Use a Claim to draw a Conclusion and provide Specific Support for the Claim.	2	2	2	2	2
<b>LFD5</b> Use a Claim to draw a Conclusion and provide General Support for the Claim.	3	3	2	2	2
<b>LFD6</b> Use a Specific Statement and a General Statement to draw a Conclusion.	3	3	2	2	2
<b>VIS3</b> Draw and label a visual representation that illustrates a mathematical concept, property, or relationship and use the labeling in one's prose to clarify an argument.	3	3	3	2	2
<b>N-EXA</b> Use proof by example.	3	3	3	2	2
<b>CON2</b> Conclude from a conditional statement.	3	3	3	2	2
<b>ERR2</b> Indicate an error and use a mathematical concept (definition, theorem, or axiom) to explain why an error occurred.	3	3	3	3	2
<b>CNE2</b> Provide a counterexample and verify that the conditional conclusion does not hold for the example.	3	3	3	3	2

Table 1 (continued)

Justification statement	JE level at grade:				
	3–4	5	6–7	8	10
<b>CNV</b> Understand that a statement can be true and its converse or inverse can be false.	3	3	3	3	2
<b>N-CNV</b> States that the converse or inverse of a conditional statement is true because the original statement is true.	3	3	3	3	2
<b>CLA1</b> State that an object belongs (or does not belong) to a class, state at least one of the common characteristics of the class, and state that the object has (or does not have) those characteristics.	3	3	3	3	2
<b>LFD7</b> Use two or more Specific Statements to draw a Conclusion and provide Specific Support for at least one of the Statements.	3	3	3	3	2
<b>LFD8</b> Use two General Statements to draw a Conclusion.	3	3	3	3	2
<b>PAT3</b> Introduce a pattern or sequence and use it to support a Statement or Conclusion.	3	3	3	3	3
<b>CNE3</b> Provide a counterexample and verify that the conditional hypotheses do hold for the example, while the conditional conclusion does not.	3	3	3	3	3
<b>CON3</b> Conclude from a conditional statement and verify that the statement's hypotheses hold.	3	3	3	3	3
<b>CAS</b> Use cases in a proof.	3	3	3	3	3
<b>IND</b> Use indirect proof (e.g. proof by contradiction).	3	3	3	3	3
<b>LFD9</b> Use two or more Claims to draw a Conclusion and provide Support for at least one Claim—at least one Claim or Support must be General.	3	3	3	3	3
<b>CLA2</b> State what is required to be a member of a class, verify that an object meets all of those requirements, and then state that the object belongs to that class.	3	3	3	3	3

## Improvement Ideas

ACT Aspire includes simple improvement ideas at the reporting category (skill) level on student and parent reports. These improvement ideas are provided for the lowest performing skill for each subject tested. The skills are always ordered from highest performing to lowest performing based on the percentage of points correct. If the percentages for two or more skills are tied, the skill with the lower number of total points is displayed first.

Keep in mind that the order of skills listed on reports may not always be exemplary of where to focus learning. For example, the skills in which a student performed within the ACT Readiness Range may not always be listed first, and the skills in which a student did not perform within the ACT Readiness Range may not always be listed last. Also, keep in mind the total number of points possible in each skill when interpreting the percentage correct.

There are two levels of improvement idea statements (low and high) for ACT Aspire summative reporting. Low statements are given on the report if the student's lowest skill score is below the ACT Readiness Range for that particular skill. High statements are given on the report if the student's lowest skill score is at or above the ACT Readiness Range for that particular skill.

# Answer Key

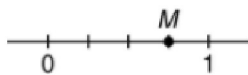
This section presents the grade, question type, DOK level, alignment to the ACT Aspire reporting categories, and correct response for each of several test questions. Each question is also accompanied by an explanation of the question and by the correct response as well as improvement idea statements for ACT Aspire Mathematics.

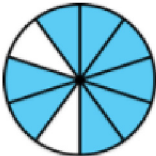
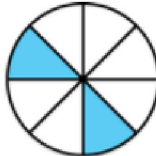
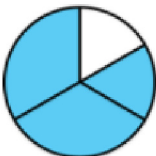
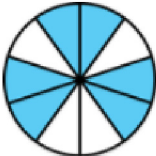
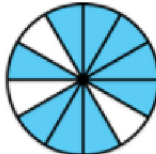
Some test questions are appropriate at several grades: as a part of Grade Level Progress when the topic is new to the grade and then in later grades as a part of Integrating Essential Skills (as long as the question is at least DOK level 2 for that grade).

## Question 1

Juliana divided the part of a number line from 0 to 1 into sections of equal length. She plotted point  $M$  on the number line, as shown below.

One of the following circles is shaded to represent a fraction that is equivalent to the number represented by point  $M$ . Which one?



- A. 
- B. 
- C. 
- D. 
- E. 



Question type	CCSSM topic	Correct response
Selected Response	3.NF.A, MP4, Recognize equivalent fractions and fractions in lowest terms (N 13–15)	E

Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Modeling	DOK level
3	Grade Level Progress > Number and Operations—Fractions	Yes	3
4–5	Integrating Essential Skills	Yes	3
6–EHS	Integrating Essential Skills	Yes	2

In this selected-response (multiple-choice) question, students must analyze the number line given and determine what fraction is being represented (CCSSM.3.NF.A.3). Because this question requires students to analyze the situation and connect different representations, it is a DOK level 3 question for the Grades 3, 4, and 5 tests. For all other ACT Aspire tests, it is a DOK level 2 question. Because students are interpreting models, this question is a part of the Modeling reporting category (MP4).

## Correct Response

After determining that the fraction at point  $M$  is  $\frac{3}{4}$ , students must then determine which of the circles provided has  $\frac{3}{4}$  of its area shaded. The circle in answer option E has 9 out of 12 equally sized sections shaded, and  $\frac{9}{12}$  is equivalent to  $\frac{3}{4}$ .

## Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Integrating Essential Skills	8	Continue to strengthen your skills by applying and integrating the mathematics you learned in previous grades.	Everybody makes mistakes. When you make one, think about what tipped you off to there being something wrong, and think about whether you could have noticed it sooner.
Modeling	8	Work on interpreting models. Identify the numbers and variables in the model and describe what they represent.	Find some real-world situations and create models to describe and predict information.

## Question 2

Explain what a line of symmetry is.

Explain why the dashed line drawn in the figure below is NOT a line of symmetry for the figure.



Question type	CCSSM topic	Correct response
Justification and Explanation (Constructed Response)	4.G.A, MP4	See explanation.

Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Integrating Essential Skills and Grade Level Progress		
		JE level	Modeling	DOK level
4	Grade Level Progress	3	Yes	3
5–8	Integrating Essential Skills	3	Yes	3
EHS	Integrating Essential Skills	2	Yes	3

This Justification and Explanation task elicits an explanation of why something is not true.

The task is crafted carefully so that successful students must give a definition and tie it to their explanation—an important way of reasoning in mathematics and in many areas of life. The context here is symmetry, a topic from Grade 4 (CCSSM.4.G.A.3, “Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry”). A response that successfully justifies the result will contain a general definition of a line of symmetry and show why that definition does not fit the specific situation shown by the drawing. This is JE level 3 reasoning for Grade 4 students and would be a part of the Grade Level Progress reporting category. The task is also a part of the JE reporting category. This task would also be appropriate for the Grades 5, 6, 7, 8, and Early High School tests where it would be a part of the Integrating Essential Skills and the JE reporting categories. While most students at these higher grades are easily able to recognize lines of symmetry, this task still requires students to use definitions and create a cohesive explanation—valuable skills to measure even if the content isn’t advanced. The reasoning skills assessed by this task are at JE level 3 for Grades 4–8 and JE level 2 for EHS. At all grades, this is a task at DOK level 3.

The figure is a possible model for the definition of a line of symmetry, and the student must judge whether the model fits, so this question contributes to the Modeling reporting category (MP4).

## Response 1

A student could receive full credit for the following sample response:

A line of symmetry is a line that divides a figure into two equal parts where you can fold along the line and make the edges match up. Folding along the given line will not make the edges match up because it does not divide the picture into two equal parts, so the dashed line is not a line of symmetry.

The primary justification skills in this response are captured by the JE statements “State that an object belongs (or does not belong) to a class, state at least one of the common characteristics of the class, and state that the object has (or does not have) those characteristics” and “Use a Specific Statement and a General Statement to draw a Conclusion.” The response also demonstrates direct evidence of “State a property or classification of an object” and “State a definition, theorem, formula, or axiom.” A response of this type demonstrates evidence of all three levels of justification at Grade 8.

This response successfully completes the assigned task by stating the definition of a line of symmetry and using that definition to conclude that the line in question was not, in fact, a line of symmetry. In addition to successfully completing the task, the response also shows understanding of the given information and the required goal, and it expresses the argument in a clear and organized manner. This response would be given a Progress score of 3. Note that the definition provided in this response may not be adequate for higher grade levels.

With Level 3 justification and a Progress score of 3, this response would be given 4 points.

## Response 2

A line of symmetry is a line that divides a figure into two equal parts where you can fold along the line and make the edges match. So the dashed line is not a line of symmetry.

This response’s justification is captured by the JE statements “State a definition, theorem, formula, or axiom” and “Use a General Statement to draw a Conclusion or Provide General Support for a Statement,” which provide evidence of the first two levels of justification at Grade 8.

This response provides a general definition of a line of symmetry and uses this general statement to arrive at the conclusion. The definition is evidence that the student understands the concept of a line of symmetry. However, explaining how the definition is connected to the given figure would have been a more thorough response. Though the correct definition was employed, the lack of thoroughness means that this response would be given a Progress score of 2.

Since the JE Level of this task is 3 at Grade 8, Level 2 justification and a Progress score of 2 would give this response 2 out of the 4 points possible.

## Response 3

You fold along the line to check for symmetry. The dashed line is not a line of symmetry.

This response’s justification is captured by the JE statements “State one or more steps in a procedure,” “Explain why a step in a procedure is necessary,” and “Use a Specific Statement to draw a Conclusion or Provide Specific Support for a Statement,” which provide evidence for the first level of justification at Grade 8. The argument could have been strengthened by explaining how folding along the line is related to being or not being a line of symmetry. This could be done, for example, by giving the definition of a line of symmetry.

This response uses a specific statement about the procedure required to test the line of symmetry of the given figure to arrive at the correct conclusion. The response demonstrates a developing understanding of the goal. However, the student failed to provide an explanation of a line of symmetry. Since some understanding of lines of symmetry is demonstrated, this response would be given a Progress score of 1.

With Level 1 justification and a Progress score of 1, this response would be given 1 out of the 4 points possible.

## Response 4

The line is not a line of symmetry because it does not divide the heart into 2 sections of equal area. If you move the line down a little, then the areas will be the same, so it will be a line of symmetry.

This response's justification is captured by the JE statements "State a property or classification of an object," "Make a conditional statement (e.g. If-Then, When-Then, etc.)," and "Use two or more Specific Statements to draw a Conclusion and provide Specific Support for at least one of the Statements," which is evidence of all three levels of justification at Grade 8. It is important to note that even though the definition given was incorrect, this does not affect the justification evidence that is present.

Even though this response gives the correct conclusion, it shows a misconception of the definition of a line of symmetry. With little else present except the misconception, this response would be given a Progress score of 0.

Even though this response would be given a Progress score of 0, the evidence of high-level justification would give this response 2 out of the 4 points possible.

## Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Justification and Explanation	8	Work on identifying reasons for mathematical steps. Can you show why the area of a triangle is always half of the base times the height?	Before you solve a math problem, predict how the solution will go and what method(s) will work.
Integrating Essential Skills	8	Continue to strengthen your skills by applying and integrating the mathematics you learned in previous grades.	Everybody makes mistakes. When you make one, think about what tipped you off to there being something wrong, and think about whether you could have noticed it sooner.
Modeling	8	Work on interpreting models. Identify the numbers and variables in the model and describe what they represent.	Find some real-world situations and create models to describe and predict information.

## Question 3

Liam is making chocolate chip cookies. The recipe calls for 1 cup of sugar for every 3 cups of flour. Liam has only 2 cups of flour.

- How much sugar should Liam use?
- Explain why your answer is correct.

Question type	CCSSM topic	Correct response
Justification and Explanation (Constructed Response)	5.NF.B, MP3, MP4	See explanation.

Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	JE level	Modeling	DOK level
5	Grade Level Progress	3	Yes	3
6–8	Integrating Essential Skills	3	No	3
EHS	Integrating Essential Skills	2	No	3

This question prompts students to explain their reasoning and tie it to a real-world problem. Logical flow, number sense, and computation are key justification elements in this question. A successful student will make sense of the real-world problem involving fractions (CCSSM.5.NF.B) and provide appropriate justification and explanation (MP3).

For Grade 5 students, this task would be a part of the Grade Level Progress reporting category. This task would also be appropriate for the Grades 6, 7, 8, and Early High School tests; it would be a part of the Integrating Essential Skills reporting category for those grades. The task is part of the JE reporting category. The reasoning required is at JE level 3 for Grades 5–8. That same reasoning is JE level 2 for the Early High School test. It is a DOK level 3 task at all grade levels.

For Grade 5, this task contributes to the Modeling reporting category. Students produce a numerical model and provide an interpretation. In higher grades this should be automatic, so this question does not contribute to the Modeling reporting category for the Grade 6 through Early High School tests.

## Response 1

A student could receive full credit for the following sample response:

Liam has 2 cups of flour, which is  $\frac{2}{3}$  of the 3 cups of flour that the recipe talks about. So he should use  $\frac{2}{3}$  of the 1 cup of sugar that the recipe talks about.  $\frac{2}{3}$  of 1 cup is  $\frac{2}{3}$  cup. Liam should use  $\frac{2}{3}$  cup of sugar.

The JE statement “Use two or more Specific Statements to draw a Conclusion and provide Specific Support for at least one of the Statements” captures the complexity of the argument. This response also uses “State one or more steps in a procedure,” “Explain why a step in a procedure is necessary,” and “State a relationship between two or more objects.” A response of this type demonstrates evidence of all three levels of justification at Grade 8.

The response successfully completes the task assigned by giving the correct amount of sugar that Liam should use and thoroughly explaining why that amount is correct. The response demonstrates one successful pathway and presents a cohesive and well-organized argument, which would give this response a Progress score of 3.

With Level 3 justification and a Progress score of 3, this response would be given 4 points.

## Response 2

Liam must use  $\frac{2}{3}$  cup of sugar. The recipe has a fixed proportion of flour and sugar. Liam does not have enough flour for the recipe, so he will have to reduce the amount of sugar to make up for that.

The primary justification skills appearing in the response are captured by JE statements “State a property or classification of an object,” “State one or more steps in a procedure,” “Explain why a step in a procedure is necessary,” and “Use two or more Specific Statements to draw a Conclusion and provide Specific Support for at least one of the Statements.” As such, this response demonstrates evidence of the first three levels of justification at Grade 8.

The response gives the correct amount of sugar, but it does not elaborate on why  $\frac{2}{3}$  is the correct value. However, it does give some reasoning as to why the amount is reduced. Elaborating further would strengthen the response. This response would be given a Progress score of 2.

With Level 3 Justification and a Progress score of 2, this response would be given 3 out of the 4 points possible for this task.

## Response 3

Liam does not have enough flour for the recipe. He should use less sugar to account for less flour. Liam should put in half a cup of sugar.

The argument structure for this response is “Use two or more Specific Statements to draw a Conclusion.” There is also evidence related to stating properties and explaining procedures present in the response. Overall, there is evidence of the first level of justification.

The response shows some understanding of Liam’s issue with trying to make cookies, but it does not have a correct amount of sugar or a fully developed explanation, resulting in a Progress score of 1.

With Level 1 justification and a Progress score of 1, this response would be given 1 out of the 4 points possible for this task.

## Response 4

Liam should still use 1 cup of sugar. The amount of sugar doesn’t change with 2 cups of flour.

The response fails to show understanding of fractions, which would result in a Progress score of 0; however, it still receives credit for justification being present. The argument structure is “Use a Specific Statement and a General Statement to draw a Conclusion,” which is evidence of just the first level of justification.

With Level 1 justification and a Progress score of 0, this response would be given 1 out of the 4 points possible for this task.

## Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Justification and Explanation	8	Work on identifying reasons for mathematical steps. Can you show why the area of a triangle is always half of the base times the height?	Before you solve a math problem, predict how the solution will go and what method(s) will work.
Integrating Essential Skills	8	Continue to strengthen your skills by applying and integrating the mathematics you learned in previous grades.	Everybody makes mistakes. When you make one, think about what tipped you off to there being something wrong, and think about whether you could have noticed it sooner.

## Question 4

Nigel's class placed 10 empty rain gauges on the playground Monday morning. The line plot below shows the number of inches of rainwater in each gauge after it rained Monday afternoon.

Number of Inches of Rainwater



What is the mean amount of rainwater per rain gauge, in inches, in the 10 rain gauges?

- A.  $\frac{25}{80}$
- B.  $\frac{5}{8}$
- C.  $\frac{51}{80}$
- D.  $\frac{37}{56}$
- E.  $\frac{51}{8}$

Question type	CCSSM topic	Correct response
Selected Response	6.SP.B, Extract relevant data from a basic table or chart and use the data in a computation (S 16–19)	C

Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Modeling	DOK level
6	Grade Level Progress > Statistics and Probability	No	3
7–EHS	Integrating Essential Skills	No	2

This question requires students to provide evidence that they can summarize and describe distributions (CCSSM.6.SP.B). This question is part of the Statistics and Probability reporting category within the Grade Level Progress component of the Grade 6 test as a DOK level 3 question. This question requires that students be able to interpret a line plot and use that information to summarize the data by calculating and differentiating quantitative measures of center. This question builds on previous skills regarding line plots and computation with fractions of unlike denominators (CCSSM.5.MD.B.2 and CCSSM.5.NF.A.1). This question could be part of the Integrating Essential Skills component for the Grades 7, 8, and Early High School tests as a DOK level 2 question.

### Correct Response

The key for this question is  $\frac{51}{80}$ , which is answer option C. The correct response demonstrates evidence that the student can identify equivalent fractions with like denominators, add those fractions, and find the mean by dividing the total by 10 (the number of rain gauges).



## Improvement Idea Statements

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Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Integrating Essential Skills	8	Continue to strengthen your skills by applying and integrating the mathematics you learned in previous grades.	Everybody makes mistakes. When you make one, think about what tipped you off to there being something wrong, and think about whether you could have noticed it sooner.

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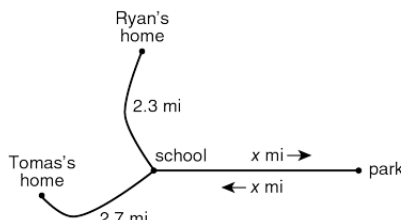
## Question 5

Ryan and Tomas walked to school and then to the park, as described below.

Ryan walked 2.3 miles from his home to meet Tomas at school.

Tomas walked 2.7 miles from his home to meet Ryan at school.

Once they were at school, the boys walked  $x$  miles to the park and then  $x$  miles back to the school.



The sum of the distance Ryan walked and the distance Tomas walked was at least 15 miles but not more than 21 miles. One of the following is the graph of the possible values of  $x$ . Which one?

- A.
- B.
- C.
- D.
- E.

Question type	CCSSM topic	Correct response	
Selected Response	7.EE.B, MP4, Match compound inequalities with their graphs on the number line (e.g., $-10.5 < x < 20.3$ ) (A 24–27)	A	
Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Modeling	DOK level
7	Grade Level Progress > Expressions and Equations	Yes	3
8, EHS	Integrating Essential Skills	Yes	2

In this selected-response question, the student needs to find the total distance that Ryan and Tomas walked by setting up an inequality with the variable  $x$  and solving. The solution then needs to be matched to the correct number line representation (CCSSM.7.EE.B.4).

### Correct Response

The correct response is the graph of the solution to the inequality  $15 \leq (2.3 + 2x + 2.7 + 2x) \leq 21$ , which is answer option A. This question assesses DOK level 3 skills on the Grade 7 test and is part of the Expressions and Equations reporting category within the Grade Level Progress reporting category. On the Grade 8 or Early High School tests, the question would assess DOK level 2 skills as part of the Integrating Essential Skills reporting category. Students produce an inequality to model the situation, and this question is part of the Modeling reporting category.

## Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Integrating Essential Skills	8	Continue to strengthen your skills by applying and integrating the mathematics you learned in previous grades.	Everybody makes mistakes. When you make one, think about what tipped you off to there being something wrong, and think about whether you could have noticed it sooner.
Modeling	8	Work on interpreting models. Identify the numbers and variables in the model and describe what they represent.	Find some real-world situations and create models to describe and predict information.

## Question 6

A store is having a sale on 3 different items. Each sign below shows the original price of an item and how to calculate the discount for that item. Click and drag the signs below to place them in order from least amount of **discount** to greatest amount of **discount**.

Question type	CCSSM topic	Correct response
Technology Enhanced	7.RP.A, MP4, Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and estimating by using a given average value in place of actual values (A 20–23)	

Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Modeling	DOK level
7	Grade Level Progress > Ratios and Proportional Relationships	Yes	3
8, EHS	Integrating Essential Skills	No	2

This technology-enhanced problem provides evidence of the student's ability to use proportional relationships to solve percent problems (CCSSM.7.RP.A.3), a skill that is frequently used in everyday encounters outside the classroom. When placed on the Grade 7 test, this question is part of the Ratios and Proportional Relationships reporting category within the Grade Level Progress reporting category. It is part of the Integrating Essential Skills reporting category on the Grade 8 and Early High School tests.

### Correct Response

The problem requires that students calculate multiple percentages and perform subtraction in the correct order according to the given information. They must pay careful attention to the fact that the question is asking for the order of the discount and not the final sale price. The correct answer puts the original prices in the order (from left to right) \$25.00, \$30.00, and \$24.00.

The process followed to solve this question requires some interpretation for students in Grade 7 and is therefore a DOK level 3 skill on the Grade 7 test. The process becomes more routine in Grade 8, so it would be a DOK level 2 problem on the Grade 8 and Early High School tests. The problem contributes to the Modeling reporting category at Grade 7 because the student is modeling the descriptions on the signs with numerical calculations. For higher grades, this skill should be more automatic and drops off the list of what contributes to the Modeling reporting category.

## Improvement Idea Statements

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Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Integrating Essential Skills	8	Continue to strengthen your skills by applying and integrating the mathematics you learned in previous grades.	Everybody makes mistakes. When you make one, think about what tipped you off to there being something wrong, and think about whether you could have noticed it sooner.

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## Question 7

Click on all of the irrational numbers below.

$\sqrt{2}$

$\sqrt{4}$

$\sqrt{8}$

$\sqrt{16}$

$\sqrt{32}$

$\sqrt{64}$

$\sqrt{128}$

$\sqrt{256}$

Question type	CCSSM topic	Correct response
Technology Enhanced	8.NS.A, Apply the fact that $\pi$ is irrational and that the square root of an integer is rational only if that integer is a perfect square (N 28–32)	<div style="display: flex; flex-wrap: wrap; justify-content: space-around;"> <div style="border: 2px solid blue; padding: 2px 5px; margin: 5px;"><math>\sqrt{2}</math></div> <div style="border: 1px solid gray; padding: 2px 5px; margin: 5px;"><math>\sqrt{4}</math></div> <div style="border: 2px solid blue; padding: 2px 5px; margin: 5px;"><math>\sqrt{8}</math></div> <div style="border: 1px solid gray; padding: 2px 5px; margin: 5px;"><math>\sqrt{16}</math></div> <div style="border: 2px solid blue; padding: 2px 5px; margin: 5px;"><math>\sqrt{32}</math></div> <div style="border: 1px solid gray; padding: 2px 5px; margin: 5px;"><math>\sqrt{64}</math></div> <div style="border: 2px solid blue; padding: 2px 5px; margin: 5px;"><math>\sqrt{128}</math></div> <div style="border: 1px solid gray; padding: 2px 5px; margin: 5px;"><math>\sqrt{256}</math></div> </div>
Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Modeling DOK level
8, EHS	Grade Level Progress > The Number System	No 1

This technology-enhanced problem will provide evidence that the student knows or can figure out when the square root of a whole number is irrational (CCSSM.8.NS.A.1). This problem is part of the Number and Quantity reporting category within the Grade Level Progress reporting category for the Grade 8 test.

### Correct Response

Students can approach this problem by one of several methods that are DOK level 1. Some will recall a list of perfect squares (CCSSM.8.EE.A.2) and note that 2, 8, 32, and 128 are not on the list, making their square roots irrational numbers. Some will recall that  $\sqrt{2}$  is irrational (CCSSM.8.EE.A.2). Some will recall that if the decimal form of a number terminates, as four of these numbers' decimal forms do, then it must be rational (CCSSM.7.NS.A.2d). Some will use a calculator to see that four of these numbers have decimal forms that do not appear to either terminate or repeat, and conclude that they must be irrational (MP5).

To receive credit on technology-enhanced problems such as this, students will be required to click on all numbers that meet the question's criterion, namely  $\sqrt{2}$ ,  $\sqrt{8}$ ,  $\sqrt{32}$ , and  $\sqrt{128}$ . This promotes the idea that any procedure developed to determine when the square root of a whole number is irrational must be repeatedly and consistently applied to all eight numbers to arrive at a complete and reasonable solution.

Although this content could be assessed very well in selected-response questions, a technology-enhanced problem gives some additional advantages. By requiring that students be prepared to capture multiple values that meet the criterion listed in the stem, students must demonstrate a consistent application of the procedure they use to determine which values are irrational.

## Improvement Idea Statements

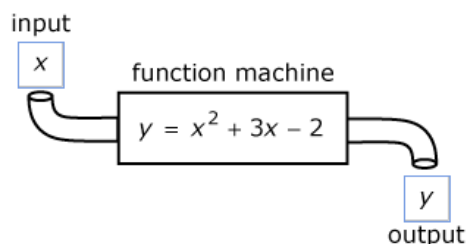
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Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Grade Level Progress	8	Ask questions when you don't understand the lesson. Start a group with classmates to study for quizzes and tests.	Try completing the "challenge" questions in your textbook for your current math work.
The Number System	8	Work on recognizing the decimal expansion of numbers. Can you find decimal approximations for irrational numbers?	In what kinds of problems do you work with irrational numbers? Make a list and share it with someone in your class.

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## Question 8

The function machine below takes an input value,  $x$ , processes that value according to the processing equation inside the function machine and creates an output value,  $y$ . From the numbers provided below the function machine, drag an input value to box  $x$  and the correct output value to box  $y$ .



0 1 2 7 8 9

Question type	CCSSM topic	Correct response
Technology Enhanced	8.F.A, Evaluate linear and quadratic functions, expressed in function notation, at integer values (F 20–23)	
Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Modeling DOK level
8, EHS	Grade Level Progress > Functions	No 2

Students use the previously developed skill of evaluating algebraic expressions containing whole number exponents (CCSSM.6.EE.A.1, 2c) to evaluate the given function—that is, to find the output of a function for a given input (8.F.1). This problem is part of the Functions reporting category within the Grade Level Progress reporting category for the Grade 8 and Early High School tests.

### Correct Response

Evaluating the expression inside the function machine at each of the six listed values will show that only two of the six values in the list yield integer outputs that are also in the list. For example,  $8 = 2^2 + 3(2) - 2$ , so  $x = 2$  and  $y = 8$  is one solution. This problem assesses DOK level 2 skills on both the Grade 8 and Early High School tests.



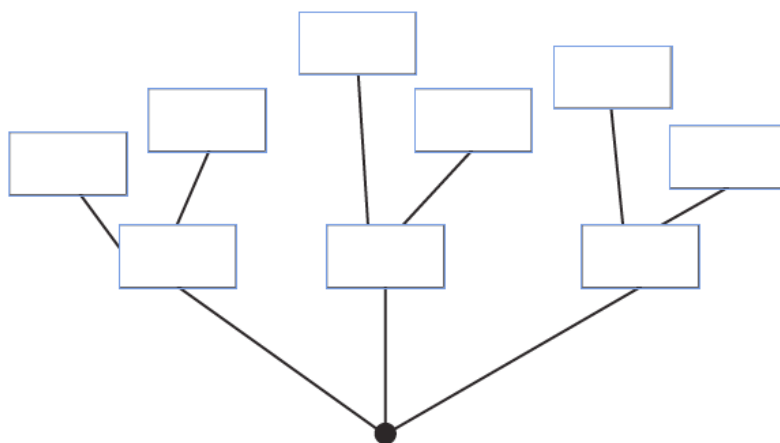
Technology-enhanced problems like this provide students with the opportunity to supply one of several possible solutions. Students are not limited by the notion that they must give the one correct answer. Students could instead select  $x = 1$  and  $y = 2$  and also receive credit for the question.

## Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Grade Level Progress	8	Ask questions when you don't understand the lesson. Start a group with classmates to study for quizzes and tests.	Try completing the "challenge" questions in your textbook for your current math work.
Functions	8	Work on understanding that linear functions have a constant rate of change. Given a word problem, can you model the situation with a linear function?	Try writing a word problem based on a real-world situation that is modeled by a linear function. What are the values that represent the slope and y-intercept in your situation?

## Question 9

Elaine's Grocery has a lunch counter where people can order 3 types of sandwiches: egg salad, chicken salad, or falafel. Sandwiches can be made with 2 types of bread: pita or baguette. Create a tree diagram by dragging and dropping the sandwich choices into the empty boxes to show all the possible combinations for a sandwich from this lunch counter.



pita	pita	pita
baguette	baguette	baguette
egg salad	egg salad	egg salad
chicken salad	chicken salad	chicken salad
falafel	falafel	falafel

Question type	CCSSM topic	Correct response	
Technology Enhanced	7.SP.C, MP4, Apply counting techniques (S 28–32)	See explanation.	
Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Modeling	DOK level
7	Grade Level Progress > Statistics and Probability	Yes	2
8, EHS	Integrating Essential Skills	Yes	2

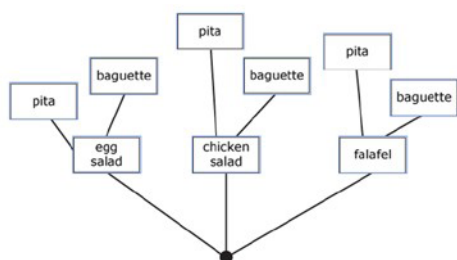
In this technology-enhanced problem, the student must demonstrate the ability to create a tree diagram to represent all the possible combinations of three sandwich types and two bread types (CCSSM.7.SP.C.8). Because the student is creating a mathematical model representing a real-world situation, this problem assesses a student's modeling skills (MP4). The student is given the framework of the model and must use the connections to the real-world situation to create a specific model for the situation. This problem is considered DOK level 2 and contributes to the

Statistics and Probability reporting category within the Grade Level Progress reporting category for the Grade 7 test. It is still DOK level 2 for the Grade 8 and Early High School tests, but on those tests the question would be part of the Integrating Essential Skills reporting category and the Modeling reporting category.

## Correct Response

To achieve a correct solution, “type of sandwich” boxes (i.e., falafel, egg salad, and chicken salad) should be moved to the three empty boxes closest to the point of origin of the tree diagram but can be placed in any order; then branching off the “type of sandwich” boxes would be the “type of bread” boxes (i.e., pita and baguette) in any order. There are 48 different correct response variations because the order within each type does not matter.

### Sample Correct Response

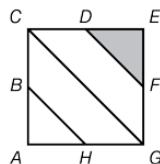


## Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Integrating Essential Skills	8	Continue to strengthen your skills by applying and integrating the mathematics you learned in previous grades.	Everybody makes mistakes. When you make one, think about what tipped you off to there being something wrong, and think about whether you could have noticed it sooner.
Modeling	8	Work on interpreting models. Identify the numbers and variables in the model and describe what they represent.	Find some real-world situations and create models to describe and predict information.

## Question 10

In square  $ACEG$  shown below,  $B$ ,  $D$ ,  $F$ , and  $H$  are the midpoints of  $\overline{AC}$ ,  $\overline{CE}$ ,  $\overline{EG}$ , and  $\overline{AG}$ , respectively. A student thinks that the area of  $\triangle DEF$ , shown shaded, is  $\frac{1}{4}$  the area of square  $ACEG$ . Explain why the student is NOT correct.



Question type	CCSSM topic	Correct response
Justification and Explanation (Constructed Response)	6.G.A, MP3, Compute the area and perimeter of triangles and rectangles in simple problems (G 20–23)	See explanation.

Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	JE level	Modeling	DOK level
6	Grade Level Progress	3	No	3
7–EHS	Integrating Essential Skills	3	No	3

This Justification and Explanation problem assesses students' ability to identify an error and use mathematical concepts to explain why it is an error. A successful student must give general mathematical truths (formulas and definitions) to support claims—an important way of justifying an argument in mathematics and everyday life. At an early age, many students incorrectly assume that if a region is divided into four parts and one part is shaded, then the area of the shaded part is one-fourth the area of the total region. In their responses, students will critique the reasoning of others (MP3).

This problem is a good example of a JE problem that could appear on any of the Grades 6, 7, 8, or Early High School tests. If appearing on the Grade 6 test, this task would be a part of the Grade Level Progress reporting category. If placed on the Grade 7, 8, or Early High School tests, it would be a part of the Integrating Essential Skills reporting category. Due to the justification and explanation required to answer this question, it would be classified as a DOK level 3 at all grade levels. At all grade levels, this task is part of the Justification and Explanation reporting category and requires JE level 3 reasoning.

## Response 1

A student could receive full credit for the following sample response:

Let's say the length of a side of the square is  $x$ . Since a midpoint will divide a segment in half,  $DE = EF = \frac{1}{2}x$ . The formula for the area of a triangle is  $A = \frac{1}{2}bh$ , so the area of  $\triangle DEF = \left(\frac{1}{2}\right)\left(\frac{1}{2}x\right)\left(\frac{1}{2}x\right) = \frac{1}{8}x^2$ . The area of  $ACEG$  is  $x^2$  because it is a square. The student said the area of  $\triangle DEF$  would be  $\frac{1}{4}$  of the area of square  $ACEG$ . The correct answer is  $\frac{1}{8}$  of the area of the square, so the student is wrong.

The primary justification skills appearing in this response are captured by the JE statements “Indicate an error occurred” and “Indicate an error and use a mathematical concept (definition, theorem, or axiom) to explain why an error occurred.” Additionally, the complex structure of the argument in the response is direct evidence of the statement “Use two or more Claims to draw a Conclusion and provide Support for at least one Claim—at least one Claim or Support must be General.” Finally, the response also demonstrates direct evidence of “State a property or classification of an object,” “State a definition, theorem, formula, or axiom,” “State a relationship between two or more objects,” and “Provide a computation.” A response of this type demonstrates evidence of all three levels of justification.

The response successfully completes the task assigned by constructing an argument that uses multiple claims, definitions, and formulas to explain why the student in the problem is incorrect. The response successfully synthesizes the given information with outside knowledge, as evidenced in the use of formulas and definitions. Furthermore, the response demonstrates understanding of the given information, uses logically consistent reasons to support mathematical claims, and expresses the argument in a clear, organized manner, which would give this response a Progress score of 3.

With Level 3 justification and a Progress score of 3, this response would be given 4 points.

## Response 2

The student is not correct because  $\triangle DEF$  is  $\frac{1}{8}$  the area of square  $ACEG$ . The area formula for a triangle is  $\frac{1}{2}bh$ , so the area of  $\triangle DEF$  is  $\frac{1}{2}(\frac{1}{2}x)(\frac{1}{2}x)$ , which is  $\frac{1}{8}x^2$ .

The primary justification skills appearing in this response are captured by the JE statements “Indicate an error occurred” and “Indicate an error and use a mathematical concept (definition, theorem, or axiom) to explain why an error occurred.” Additionally, the structure of the argument in the response would be captured by the statement “Use two or more Claims to draw a Conclusion and provide Support for at least one Claim—at least one Claim or Support must be General,” which is an advanced argument structure. Finally, the response demonstrates direct evidence of “State a property or classification of an object,” “State a definition, theorem, formula, or axiom,” “State a relationship between two or more objects,” and “Use a computation to Support a Statement or Conclusion.” This response demonstrates all three levels of justification.

This response successfully completes the task by creating an argument that explains why the student in the prompt is incorrect. This argument synthesizes given information with outside knowledge, such as the formula for the area of a triangle. However, the response could be strengthened by more clearly explaining what “ $x$ ” represents and how “ $\frac{1}{2}x$ ” was derived. This response would be given a Progress score of 2.

With Level 3 justification and a Progress score of 2, this response would be given 3 out of the 4 points possible for this task.

## Response 3

The student is not correct because the four sections aren’t the same size.

The primary justification skill appearing in this response is captured by the JE statement “Indicate an error occurred.” Moreover, the structure of the argument is captured by the statement “Use a Specific Statement to draw a Conclusion or Provide Specific Support for a Statement.” Finally, there is also direct evidence of the statement “State a relationship between two or more objects.” This response demonstrates the first level of justification.

While the response shows some understanding and has an approach that, if developed, would be successful, the response lacks thoroughness and detail. More thoroughly explaining why the sections not being the “same size” forces the area of  $\triangle DEF$  to not be  $\frac{1}{4}$  the area of square  $ACEG$  would help the quality of the response and improve the justification evidence. This response would be given a Progress score of 1.

With Level 1 justification and a Progress score of 1, this response would be given 1 out of the 4 points possible for this task.

## Response 4

The student IS correct because the square is divided into four parts and  $\triangle DEF$  is one of those parts, so it is  $\frac{1}{4}$  the area of square  $ACEG$ .

This response demonstrates a misunderstanding of the task at hand, arguing that the student is correct. This results in a Progress score of 0. However, the response still demonstrates the first level of justification by providing evidence of justification statements such as “Use two or more Specific Statements to draw a Conclusion” and “State a property or classification of an object.”

With Level 1 justification and a Progress score of 0, this response would be given 1 out of the 4 points possible for this task.

## Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Justification and Explanation	8	Work on identifying reasons for mathematical steps. Can you show why the area of a triangle is always half of the base times the height?	Before you solve a math problem, predict how the solution will go and what method(s) will work.
Integrating Essential Skills	8	Continue to strengthen your skills by applying and integrating the mathematics you learned in previous grades.	Everybody makes mistakes. When you make one, think about what tipped you off to there being something wrong, and think about whether you could have noticed it sooner.

## Question 11

A pattern exists among the units digits of the powers of 7, as shown below. What is the units digit of  $7^{50}$  ?

$$7^0 = 1 \quad 7^3 = 343 \quad 7^6 = 117,649$$

$$7^1 = 7 \quad 7^4 = 2,401 \quad 7^7 = 823,543$$

$$7^2 = 49 \quad 7^5 = 16,807 \quad 7^8 = 5,764,801$$

(Note: The units digit of 2,401 is 1.)

- A. 1
- B. 3
- C. 4
- D. 7
- E. 9

Question type	CCSSM topic	Correct response
Selected Response	5.OA.B, MP1, MP7, Exhibit knowledge of elementary number concepts such as rounding, the ordering of decimals, pattern identification, primes, and greatest common factor (N 20–23)	E

Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Modeling	DOK level
5	Grade Level Progress > Operations and Algebraic Thinking	No	3
6–EHS	Integrating Essential Skills	No	3

Mathematics is sometimes described as a study of patterns. The word “pattern” is found throughout the CCSSM. This exemplar assesses a student’s ability to recognize a pattern and use the pattern to solve a problem, a part of CCSSM Mathematical Practice 7 (MP7): “Look for and make use of structure.” The question is based on content from CCSSM cluster 5.OA.B. The question involves a relatively high level of competence with Mathematical Practice 1 (MP1): “Make sense of problems and persevere in solving them.” Understanding the place-value structure of whole numbers and operations on whole numbers, as well as more advanced relationships involving factors, multiples, and remainders are useful for finding the solution. The question is at a DOK level of 3—students must make decisions on to how to approach finding a solution.

## Correct Response

A student solution involves recognizing that the number pattern of the units digit generated by the powers of 7 repeats every 4 terms. Using that structure, the student can figure out where the 50th term fits into the pattern, which can be connected to the remainder when 50 is divided by 4.

Answer option E is the correct answer.

## Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Integrating Essential Skills	8	Continue to strengthen your skills by applying and integrating the mathematics you learned in previous grades.	Everybody makes mistakes. When you make one, think about what tipped you off to there being something wrong, and think about whether you could have noticed it sooner.



## Question 12

A student thinks that the sum of 4.3 and 8.4 is 12.7 because  $4 + 8 = 12$  and  $3 + 4 = 7$ . The student then adds 3.7 and 2.6 and gets 5.13 because  $3 + 2 = 5$  and  $6 + 7 = 13$ . Identify the mistake in the student's procedure, and explain why this procedure won't always work.

1200

Question type	CCSSM topic	Correct response
Justification and Explanation (Constructed Response)	5.NBT.B, MP3, Perform one-operation computation with whole numbers and decimals (N 13–15)	See explanation.

Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	JE level	Modeling	DOK level
5	Grade Level Progress	3	No	3
6–8	Integrating Essential Skills	3	No	3
EHS	Integrating Essential Skills	2	No	3

This task elicits an explanation of why a procedure is not always effective. When learning about decimals, students often make the mistake of just adding the digits instead of adding the value of the numbers. This task is crafted carefully so that successful students must identify the misconception and explain why it is incorrect by appealing to a general mathematical concept. The content here is place value, a topic from CCSSM Grade 5 (5.NBT.B.7). The focus is on mathematical justification, captured by CCSSM in MP3: “Create viable arguments and critique the reasoning of others.”

For Grade 5 students, this task would be a part of the Grade Level Progress reporting category. This task would also be appropriate for the Grades 6, 7, 8, and Early High School tests as a part of the Integrating Essential Skills reporting category. At Grades 5–8, this task is a part of the Justification and Explanation reporting category, requires JE level 3 reasoning, and is DOK level 3. For the Early High School test, this would be considered JE level 2.

## Response 1

A student could receive full credit for the following sample response:

The student didn't pay attention to place value and added the tenths place wrong.  $0.6 + 0.7 = 1.3$ .

The student's procedure won't always work because if you add numbers by place value and get a number greater than 9, you must carry to the next largest place value.

The heart of the justification in this response is captured by the JE statements “Indicate an error occurred” and “Indicate an error and use a mathematical concept (definition, theorem, or axiom) to explain why an error occurred.” The student uses a general mathematical concept in the response (“if you add numbers by place value and get a number greater than 9, you must carry to the next largest place value”), a skill captured by the JE statement “State a definition, theorem, formula, or axiom.” This response also provides direct evidence of “Provide a computation,” “State a relationship

between two or more objects,” and “Use a General Statement to draw a Conclusion or Provide General Support for a Statement.” A response of this type demonstrates evidence of all three levels of justification at Grade 8.

The response successfully completes the task assigned, telling why the student in the problem is incorrect and thoroughly explaining why the procedure won't always work. The response demonstrates understanding of the given information, uses logically consistent reasons to support mathematical claims, and expresses the argument in a clear, organized manner, which would give this response a Progress score of 3.

With Level 3 justification and a Progress score of 3, this response would be given 4 points.

## Response 2

The student is wrong.  $3.7 + 2.6 = 6.3$ . They made a mistake adding the tenths place values.

There are several JE statements present in the response: “Indicate an error occurred,” “Provide a computation,” “State a relationship between two or more objects,” and “Use two or more Specific Statements to draw a Conclusion.” This response demonstrates evidence of the first level of justification. A more general explanation of the properties of place value and how they apply to the error in question would have been stronger justification.

The response shows a clear understanding of how adding decimals works because it provides the correct answer. However, it would be strengthened by a more in-depth explanation of what place value error is occurring and how it can be corrected. This response would be given a Progress score of 2.

With Level 1 justification and a Progress score of 2, this response would be given 2 out of the 4 points possible for this task.

## Response 3

$3.7 + 2.6 = 6.3$ , not 5.13.

The response provides a correct answer but no explanation, which gives this response a Progress score of 1. However, it does have evidence of the justification statements “Indicate an error occurred,” “Provide a computation,” and “State a relationship between two or more objects,” all of which are Level 1 statements for Grade 8.

With Level 1 justification and a Progress score of 1, this response would be given 1 out of the 4 points possible for this task.

## Response 4

The student started out okay but then messed up.  $6 + 7 = 13$ . Since  $6 + 7$  is bigger than 9, you have to carry the 1. You have to add that 1 to the 3, as in  $1 + 3 = 4$ .  $3.7 + 2.6 = 5.4$ .

The response indicates awareness of an error in adding, but the response's explanation of the error shows a lack of understanding for how carrying should work when adding decimals. Therefore, the response would be given a Progress score of 0. However, the response does use justification that is captured by the JE statements “Indicate an error occurred,” “Provide a computation,” “State a relationship between two or more objects,” and “Explain why a step in a procedure is necessary,” which is evidence of the first level of justification.

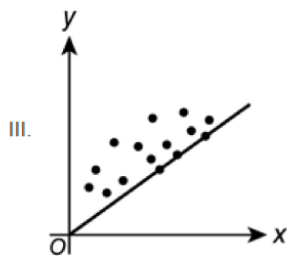
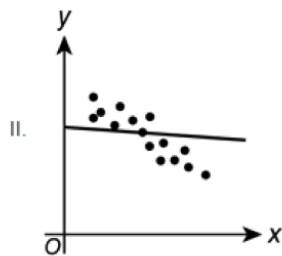
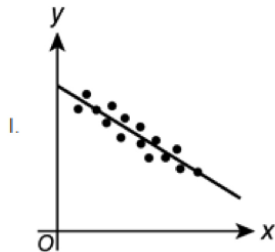
With Level 1 justification and a Progress score of 0, this response would be given 1 point out of the 4 points possible for this task.

## Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Justification and Explanation	8	Work on identifying reasons for mathematical steps. Can you show why the area of a triangle is always half of the base times the height?	Before you solve a math problem, predict how the solution will go and what method(s) will work.
Integrating Essential Skills	8	Continue to strengthen your skills by applying and integrating the mathematics you learned in previous grades.	Everybody makes mistakes. When you make one, think about what tipped you off to there being something wrong, and think about whether you could have noticed it sooner.

## Question 13

The scatterplots below are of 3 different data sets graphed in the standard  $(x, y)$  coordinate plane. Each data set has a line of fit shown in the scatterplot. Which of the scatterplots below has(have) a line that fits the data well?



- A. I only
- B. II only
- C. III only
- D. I and III only
- E. I, II, and III

Question type	CCSSM topic	Correct response	
Selected Response	8.SP.A.2, MP4	A	
Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Modeling	DOK level
8, EHS	Grade Level Progress > Statistics and Probability	Yes	1

This question assesses a student’s ability to informally evaluate the fit of a linear model for a given data set (CCSSM.8.SP.A.2), represented as a scatterplot, by examining how close the collection of data points is to a given line. Students who exhibit the modeling skill described by CCSSM.MP4 will see that Scatterplot I has a line that follows the data set reasonably closely, though perhaps not perfectly. This will be in contrast to Scatterplots II and III, which have linear models that could be significantly improved by adjusting the slope and intercept of the line, respectively. This question could appear on the Grade 8 or Early High School tests because it is part of the Statistics and Probability reporting category within Grade Level Progress.

## Correct Response

The correct answer is Option A. Since the linear model shown in Scatterplot I could not be significantly improved, the student can conclude that the line fits the data well. The linear model in Scatterplot II predicts data at the low and high end of the  $x$  values poorly, which could be significantly improved by making the line have a more negative slope. The linear model in Scatterplot III consistently predicts  $y$  values too low at nearly every value of  $x$ , which could be significantly improved by increasing the value of the  $y$ -intercept of the line, so the student can conclude that Scatterplots II and III do not have lines that fit the data well.

## Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Grade Level Progress	8	Ask questions when you don’t understand the lesson. Start a group with classmates to study for quizzes and tests.	Try completing the “challenge” questions in your textbook for your current math work.
Statistics and Probability	8	Work on finding patterns between two quantities as seen in scatterplots and modeling with linear functions.	Find a scatterplot on the internet and create a linear function that models the data. Interpret the slope and intercept in relation to the data.
Modeling	8	Work on interpreting models. Identify the numbers and variables in the model and describe what they represent.	Find some real-world situations and create models to describe and predict information.

## Question 14

A cone and 2 cylinders are shown below. The volume of the cone is 15 cubic centimeters. Each of the 2 cylinders has the same height and the same radius as the cone. What is the combined volume, in cubic centimeters, of the 2 cylinders?



- A. 5
- B. 10
- C. 30
- D. 45
- E. 90

Question type	CCSSM topic	Correct response
Selected Response	8.G.C.9, Use relationships involving area, perimeter, and volume of geometric figures to compute another measure (G 28–32)	E

Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Modeling	DOK level
8, EHS	Grade Level Progress > Geometry	No	3

This question assesses students' ability to apply their knowledge of volume concepts and formulas (CCSSM.8.G.C.9) to a nonroutine mathematical problem. The student must use the given information about the cone and relate the measurements to the 2 identical cylinders. A variety of approaches may be used, and some students may accelerate their solution if they notice that the volume of a cylinder is exactly 3 times the volume of a cone when the radius and height of the two solids are equal. This is a DOK level 3 question since a nonroutine solution path must be generated by the student. On the Early High School test, students may be more familiar with the evaluation of the relevant for formulas and may use a more algebraic approach to outlining and generating their solution.

### Correct Response

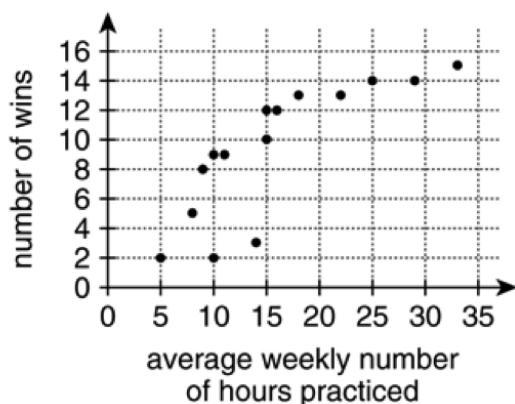
For radius  $r$  and height  $h$ , the volume of a cone is  $\frac{1}{3}\pi r^2 h$  and the volume of a cylinder is  $\pi r^2 h$ . For the given cone, this is  $15 = \frac{1}{3}\pi r^2 h$ , which is equivalent to  $45 = \pi r^2 h$  by algebraic manipulation. Since the cylinders also have radius  $r$  and height  $h$ , this manipulated equation gives the volume of a single cylinder, 45 cubic centimeters. The combined volume of the 2 identical cylinders is then  $2 \times 45 = 90$  cubic centimeters, Option E.

## Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Grade Level Progress	8	Ask questions when you don't understand the lesson. Start a group with classmates to study for quizzes and tests.	Try completing the "challenge" questions in your textbook for your current math work.
Geometry	8	Work on applying the Pythagorean Theorem. Can you express a congruence relationship in terms of reflections, rotations, and translations?	Create a set of directions including at least 4 transformations (rotations, reflections, and translations) that will take a polygon and map it onto itself.

## Question 15

Fifteen dancers participated in competitions over the last year. Each point in the scatterplot below represents the average weekly number of hours practiced and the number of wins in competitions for one of the dancers.



One of the following describes the association between the average weekly number of hours practiced and the number of wins. Which one?

- A. Positive, linear, at least 1 outlier
- B. Negative, linear, at least 1 outlier
- C. Positive, nonlinear, at least 1 outlier
- D. Negative, nonlinear, no outliers
- E. Negative, nonlinear, at least 1 outlier

Question type	CCSSM topic	Correct response
Selected Response	8.SP.A.1, Analyze and draw conclusions based on information from tables and charts, including two-way frequency tables (S 33–36)	C
Appropriate Grade Level(s)	Integrating Essential Skills and Grade Level Progress Reporting Categories	Modeling DOK level
8, EHS	Grade Level Progress > Statistics and Probability	Yes 2



This question assesses a student’s ability to identify patterns in data on a scatterplot. Students must determine whether the data have a positive or negative association, a linear or nonlinear association, and if there are any apparent outliers in the data (CCSSM.8.SP.A.1). Using informal methods, students should notice that the trend in the data rises quickly from 5 to 10 hours of practice, then gradually rises less quickly as the amount of practice increases. This behavior implies a curve, rather than a line, would best fit the data.

## Correct Response

Since the number of wins tends to increase as the number of hours increases, there is a positive association in the data. The trend appears to be nonlinear because the rate of increase in the number of wins tends to decrease as the number of hours of practice goes up. The data point near (14,3) appears to be one outlier, and another possibility is located near (10,2). Therefore, the correct answer is Option C.

## Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Grade Level Progress	8	Ask questions when you don’t understand the lesson. Start a group with classmates to study for quizzes and tests.	Try completing the “challenge” questions in your textbook for your current math work.
Statistics and Probability	8	Work on finding patterns between two quantities as seen in scatterplots and modeling with linear functions.	Find a scatterplot on the internet and create a linear function that models the data. Interpret the slope and intercept in relation to the data.
Modeling	8	Work on interpreting models. Identify the numbers and variables in the model and describe what they represent.	Find some real-world situations and create models to describe and predict information.

## Question 16

The distance between Earth and the Moon is approximately  $2.39 \times 10^5$  miles. To the nearest hour, how long would it take for a space shuttle traveling 18,000 mph to make a round-trip from Earth to the Moon and back?

- A. 13
- B. 27
- C. 301
- D. 1,328
- E. 7,531

Question type	CCSSM topic	Correct response
Selected Response	8.EE.A.4, MP4, Solve multistep arithmetic problems that involve planning or converting common derived units of measure (AF 24–27)	B

Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Modeling	DOK level
8	Grade Level Progress > Expressions and Equations	Yes	2
EHS	Grade Level Progress > Algebra	Yes	2

This question assesses a student's ability to perform calculations with numbers in scientific notation (CCSSM.8.EE.A.4) in the context of constant rates of movement (CCSSM.6.RP.A.3.b). This is considered a DOK level 2 skill because students must apply their computational ability to a real-world situation and set up a basic rate model (CCSSM.MP4) appropriately. On the Grade 8 test, this question would be in the Expressions and Equations reporting category. On the Early High School test, it would contribute to the Algebra reporting category. Both categories are in Grade Level Progress for their respective tests.

### Correct Response

The correct response is Option B. Since the shuttle is making a round-trip to the moon, the distance it needs to travel is  $2 \times 2.39 \times 10^5 \text{ miles} = 4.78 \times 10^5 \text{ miles}$ . The space shuttle is traveling 18,000 miles per hour, or  $1.8 \times 10^4 \frac{\text{miles}}{\text{hour}}$ . Using units to set up the rate equation  $1.8 \times 10^4 \frac{\text{miles}}{\text{hour}} \times t \text{ hours} = 4.78 \times 10^5 \text{ miles}$ , the shuttle will travel  $4.78 \times 10^5 \text{ miles}$  in  $t$  hours. Solving for  $t$  by division and using properties of exponents results in  $\frac{4.78 \times 10^5 \text{ miles}}{1.8 \times 10^4 \frac{\text{miles}}{\text{hour}}} = \frac{4.78}{1.8} \times 10^{5-4} \text{ hours} \approx 2.7 \times 10^1 \text{ hours} = 27 \text{ hours}$ .

## Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Grade Level Progress	8	Ask questions when you don't understand the lesson. Start a group with classmates to study for quizzes and tests.	Try completing the "challenge" questions in your textbook for your current math work.
Expressions and Equations	8	Work on understanding how to work with integer components and scientific notation. Can you make connections between proportional relationships, lines, and linear equations?	Find some real-world data expressed in scientific notation. What new information can you produce using operations on that data?
Modeling	8	Work on interpreting models. Identify the numbers and variables in the model and describe what they represent.	Find some real-world situations and create models to describe and predict information.

## Question 17

Molly built a dollhouse that is a scale model of her home. The floor plan for the bottom floor of the dollhouse is shown below, with measurements in inches. The rooms and hall are represented by rectangles.

Molly painted the floors of the 2 rooms and the hall shown in the floor plan. To the nearest 0.01, what is the total area, in square inches, that Molly painted?

Type your answer in decimal form to the hundredths place in the box.

square inches

Question type	CCSSM topic	Correct response
Technology Enhanced	4.MD.A, MP6, Compute the area and perimeter of triangles and rectangles in simple problems (G 20–23)	See explanation.

Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Modeling	DOK level
7–8	Integrating Essential Skills	No	3
EHS	Integrating Essential Skills	No	2

This question is the first of three questions related to common information. These three questions are independent of each other in that it is not necessary to obtain the correct solution to one question in order to answer any of the other questions. Sets of questions like these require students to extract only the information needed to answer a particular question. This provides an additional cognitive demand on students that standalone questions may not and reinforces a skill that effective consumers of information have.

### Correct Response

This free-response problem provides evidence of the student's ability to solve a word problem involving measurements given in decimal form (CCSSM.4.MD.A). In order to provide a correct response, the student must accurately calculate the answer to the requested precision (MP6). The student must find the area for each of the rooms and calculate the sum, obtaining a correct answer of 67.68. For students taking the Grades 7 or 8 tests, this problem would be considered nonroutine due to the fact that the student must find the missing dimensions in order to calculate the total area (DOK level 3). This problem is part of the Integrating Essential Skills reporting category for the Grades 7, 8, and Early High School tests.

## Improvement Idea Statements

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Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Integrating Essential Skills	8	Continue to strengthen your skills by applying and integrating the mathematics you learned in previous grades.	Everybody makes mistakes. When you make one, think about what tipped you off to there being something wrong, and think about whether you could have noticed it sooner.

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## Question 18

Note: 1 inch in the model represents 2.5 feet in the home.

Molly added curtains along the entire length of 1 of the shortest walls in the dining room. To determine the length, in inches, of material she needed, she found the value of the expression  $3.6(1.05)$ .

What are the measurements, **in feet**, of the rooms and hall on the bottom floor of Molly's home that correspond to the measurements shown in the floor plan?

Drag the numbers into the empty boxes.

3	3.7	4	4.9	6	6.1	7	7.3
9	9.7	10	12	14	15	16	18

Question type	CCSSM topic	Correct response
Technology Enhanced	7.G.A, Solve routine one-step arithmetic problems using positive rational numbers, such as single-step percent (A 16–19)	

Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Modeling	DOK level
7	Grade Level Progress > Geometry	Yes	2
8, EHS	Integrating Essential Skills	No	2

This question is the second of three questions related to common information. This question is a DOK level 2 question for both the Grade 7 and Grade 8 tests. It is part of the Geometry reporting category within Grade Level Progress when placed on the Grade 7 test, and it is part of the Integrating Essential Skills reporting category when placed on the Grade 8 or Early High School tests.

At Grade 7, this problem would contribute to the Modeling reporting category. At Grades 8 and above, producing this model should be automatic and therefore this question is not counted in the Modeling reporting category for the Grade 8 or Early High School tests.

## Correct Response

In this question, students must determine actual lengths given information from a scale drawing (CCSSM.7.G.A.1). Students are given a conversion factor and must set up the correct proportions to determine the lengths of the rooms in the actual home, drawing on previous knowledge of proportional relationships (CCSSM.6.RP).

Moving clockwise around the figure, the missing lengths are 15, 18, 12, 9, 6, and 3. The process the student uses to determine one length must be repeatedly and consistently applied to determine all lengths.

## Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Integrating Essential Skills	8	Continue to strengthen your skills by applying and integrating the mathematics you learned in previous grades.	Everybody makes mistakes. When you make one, think about what tipped you off to there being something wrong, and think about whether you could have noticed it sooner.

## Question 19

Molly built a dollhouse that is a scale model of her home. The floor plan for the bottom floor of the dollhouse is shown below, with measurements in inches. The rooms and hall are represented by rectangles.

Which of the following expressions is equivalent to the expression Molly used to determine the length, in inches, of material she needed for curtains?

- A.  $3.6(0.05)$
- B.  $3.6 + 0.05$
- C.  $3.6 + 5(3.6)$
- D.  $3.6(1 + 1.05)$
- E.  $3.6(1 + 0.05)$

Question type	CCSSM topic	Correct response
Selected Response	7.EE.A, MP2, Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$ ) (A 13–15)	E

Appropriate grade level(s)	Integrating Essential Skills and Grade Level Progress reporting categories	Modeling	DOK level
7	Grade Level Progress > Expressions and Equations	No	2
8, EHS	Integrating Essential Skills	No	2

This question is the third and final question in a set related to common information. This question is part of the Expressions and Equations reporting category within the Grade Level Progress reporting category for the Grade 7 test; it is part of the Integrating Essential Skills reporting category for the Grade 8 and the Early High School tests.

### Correct Response

In this selected-response question, the student is required to identify an expression written in a form that demonstrates how quantities of interest can be represented in equivalent mathematical forms (CCSSM.7.EE.A), making sense of quantities in a problem situation (MP2). To arrive at the correct answer in answer option E, the student should recognize that 1.05 can be written as  $1 + 0.05$ . The ability to represent a percent increase in various but equivalent forms is a DOK level 2 skill for Grades 7 through EHS.

### Improvement Idea Statements

Reporting category	Grade	Low statement (scored below ACT Readiness Range)	High statement (scored at or above ACT Readiness Range)
Integrating Essential Skills	8	Continue to strengthen your skills by applying and integrating the mathematics you learned in previous grades.	Everybody makes mistakes. When you make one, think about what tipped you off to there being something wrong, and think about whether you could have noticed it sooner.