

Exemplar Mathematics Test Questions

Computer-Based Tests



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We invite educators, administrators, and policymakers to learn about ACT Aspire™ by viewing the collection of sample computer-based test (CBT) questions online and in this booklet. The questions illustrate a variety of content from across grade bands and show different types of test questions and formats. This booklet also explains the concepts being measured and provides an answer key for the exemplar questions.

The exemplar ACT Aspire test questions should be accessed online with a desktop or laptop computer rather than a tablet or smartphone. Please note that the platform in which the questions are currently housed does not represent the final platform on which the ACT Aspire assessment will be delivered.

Login Information

To view the exemplar ACT Aspire CBT questions online, visit tn.actaspire.org. Usernames and passwords for the various subject areas can be found in the following table.

| Subject | Username | Password |
|-----------------|----------|-----------|
| English | english | actaspire |
| Reading | reading | actaspire |
| Math | math | actaspire |
| Science | science | actaspire |
| Writing Grade 9 | writing9 | actaspire |
| Writing Grade 8 | writing8 | actaspire |
| Writing Grade 7 | writing7 | actaspire |
| Writing Grade 6 | writing6 | actaspire |
| Writing Grade 5 | writing5 | actaspire |
| Writing Grade 4 | writing4 | actaspire |
| Writing Grade 3 | writing3 | actaspire |

Technical Support

For technical support related to this exemplar set of ACT Aspire CBT questions, please contact us by phone at 888.802.7502 or by email at actaspire_implementation@actaspire.org.

Additional Information

For more information about the ACT Aspire assessment system, visit www.discoveractaspire.org.

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Introduction

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.

ACT Aspire 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.

Foundation

The Foundation 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 Foundation 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 ACT Aspire Mathematics Test

The structure of the ACT Aspire Mathematics test is the same from grade 3 through early high school (EHS), 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 somewhat more coherent.) Within this structure of content comes a level of rigor represented in part by a distribution of depth of knowledge (DOK) through Webb's level 3.¹ The Foundation 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 Foundation reporting category.

Level 2 JE skills are those most closely aligned with grade-level focus. Level 3 JE skills are more advanced, and level 1 JE skills are those where students should have a fluent command. 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.

¹ 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>.

Table 1. Justification and Explanation Skills Progression

| Justification statement | JE level at grade: | | | | |
|--|--------------------|---|-----|---|-----|
| | 3–4 | 5 | 6–7 | 8 | EHS |
| Provide an example. | 1 | 1 | 1 | 1 | 1 |
| State a definition, theorem, formula, or axiom. | 1 | 1 | 1 | 1 | 1 |
| State a property or classification of an object. | 1 | 1 | 1 | 1 | 1 |
| State a relationship between two or more objects. | 1 | 1 | 1 | 1 | 1 |
| State one or more steps in a procedure. | 1 | 1 | 1 | 1 | 1 |
| Provide a visual representation. | 1 | 1 | 1 | 1 | 1 |
| Provide a computation. | 1 | 1 | 1 | 1 | 1 |
| Use a Specific Statement to draw a Conclusion or Provide Specific Support for a Statement. | 1 | 1 | 1 | 1 | 1 |
| Explain a pattern using words, algebraic expressions, or numeric operations – OR – generate a sequence from a rule. | 2 | 1 | 1 | 1 | 1 |
| Use two or more Specific Statements to draw a Conclusion. | 2 | 1 | 1 | 1 | 1 |
| Indicate an error occurred. | 2 | 1 | 1 | 1 | 1 |
| Explain why a step in a procedure is necessary. | 2 | 2 | 2 | 1 | 1 |
| Make a conditional statement (e.g., If-Then, When-Then). | 2 | 2 | 2 | 1 | 1 |
| Draw and label a visual representation that illustrates a mathematical concept, property, or relationship. | 2 | 2 | 2 | 1 | 1 |
| Use a pattern or sequence to support a Statement or Conclusion. | 2 | 2 | 2 | 1 | 1 |
| Provide a counterexample of a conditional statement. | 2 | 2 | 2 | 2 | 2 |
| Use a General Statement to draw a Conclusion or Provide General Support for a Statement. | 2 | 2 | 2 | 2 | 2 |
| Use a Claim to draw a Conclusion and provide Specific Support for the Claim. | 2 | 2 | 2 | 2 | 2 |
| Use a Claim to draw a Conclusion and provide General Support for the Claim. | 3 | 3 | 2 | 2 | 2 |
| Use a Specific Statement and a General Statement to draw a Conclusion. | 3 | 3 | 2 | 2 | 2 |
| 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 |
| Provide a computation and reference the computation in one's prose to clarify an argument. | 3 | 3 | 3 | 2 | 2 |
| Use proof by example.* | 3 | 3 | 3 | 2 | 2 |
| Conclude from a conditional statement. | 3 | 3 | 3 | 2 | 2 |
| Indicate an error and use a mathematical concept (definition, theorem, or axiom) to explain why an error occurred. | 3 | 3 | 3 | 3 | 2 |

* This statement represents evidence of misconceptions.

Table 1 (continued)

| Justification statement | JE level at grade: | | | | |
|--|--------------------|---|-----|---|-----|
| | 3–4 | 5 | 6–7 | 8 | EHS |
| Provide a counterexample and verify that the conditional conclusion does not hold for the example. | 3 | 3 | 3 | 3 | 2 |
| Understand that a statement can be true and its converse or inverse can be false. | 3 | 3 | 3 | 3 | 2 |
| State that the converse or inverse of a conditional statement is true because the original statement is true.* | 3 | 3 | 3 | 3 | 2 |
| 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 |
| 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 |
| Use two General Statements to draw a Conclusion. | 3 | 3 | 3 | 3 | 2 |
| Introduce a pattern or sequence and use it to support a Statement or Conclusion. | 3 | 3 | 3 | 3 | 3 |
| 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 |
| Conclude from a conditional statement and verify that the statement's hypotheses hold. | 3 | 3 | 3 | 3 | 3 |
| Use cases in a proof. | 3 | 3 | 3 | 3 | 3 |
| Use indirect proof (i.e., proof by contradiction). | 3 | 3 | 3 | 3 | 3 |
| 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 |
| 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 |

* This statement represents evidence of misconceptions.

Answer Key

These exemplar test questions do not form a complete test. These questions give a flavor of ACT Aspire test questions through the grades. 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 Foundation (as long as the question is at least DOK level 2 for that grade).

Each exemplar is described on the following pages. The description includes what is being assessed and where that fits into the ACT College and Career Readiness Standards (ACT CCRS) and the CCSSM. (Through grade 7 the two are the same.) Each description also includes ties to ACT Aspire reporting categories, the DOK level for applicable grades, a brief explanation of how to solve the problem, and other general comments.

Question 1

| Sequence | Question type | CCSSM topic | Correct response |
|----------|---|---|------------------|
| 1 | Justification & 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) | Foundation and Grade Level Progress reporting categories | JE level | DOK level |
|----------------------------|--|----------|-----------|
| 5 | Grade Level Progress > Number & Operations in Base 10 | 3 | 3 |
| 6–8 | Foundation | 3 | 3 |
| EHS | Foundation | 2 | 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 ACT Aspire Number and Operations in Base 10 reporting category within 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 Foundation 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.

Explanation of Correct Response

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."

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.

Question 2

HOME / MATH EXEMPLARS / SECTION 1 / 2 OF 29

1:35:32 | F. Last

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

| | | |
|------------|----------------|-------------------|
| $7^0 = 1$ | $7^3 = 343$ | $7^6 = 117,649$ |
| $7^1 = 7$ | $7^4 = 2,401$ | $7^7 = 823,543$ |
| $7^2 = 49$ | $7^5 = 16,807$ | $7^8 = 5,764,801$ |

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

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

| Sequence | Question type | CCSSM topic | Correct response |
|----------|-------------------|--|------------------|
| 2 | 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) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 5 | Grade Level Progress > Operations & Algebraic Thinking | 3 |
| 6–EHS | Foundation | 3 |

Mathematics is sometimes described as a study of patterns. The word “pattern” is found throughout 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.

Explanation of 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.

Question 3

Explain why there are no solutions to the system of inequalities given below.

$$\begin{cases} y < -\frac{1}{2}x - 3 \\ y > -\frac{1}{2}x + 2 \end{cases}$$

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| Sequence | Question type | CCSSM topic | Correct response |
|----------|---|--|------------------|
| 3 | Justification & Explanation (Constructed Response) | A-REI.D, MP3, MP7, Solve systems of two linear equations (A 28–32) | See explanation. |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | JE level | DOK level |
|----------------------------|--|----------|-----------|
| EHS | Grade Level Progress > Algebra | 3 | 3 |

This task elicits an explanation of why a system of linear inequalities has no solution. Logical flow is a key element to creating a viable argument that justifies the statement (MP3). Using appropriate definitions to support claims leads to a correct conclusion and successfully creates a complex argument. The content here is solving systems of inequalities—a high school algebra topic—and uses ACT CCRS “Solve systems of two linear equations.” The content is in CCSSM as A-REI.D, but another important element is using the structure of lines with similar equations to deduce something about the lines (MP7).

For EHS, this task would be a part of the Algebra reporting category within the Grade Level Progress reporting category. This task requires JE level 3 reasoning and is part of the JE reporting category. It is a DOK level 3 task.

Explanation of Correct Response

The reasoning in the following sample response is within reach of an EHS student and would receive full credit.

$y = x/2 - 3$ and $y = x/2 + 2$ have the same slope and so are parallel and never intersect. The first line is 5 units below the second line when $x = 0$. Because the lines are parallel, it is always below the second line. The solutions of $y < x/2 - 3$ are the points in the plane below the first line. The solutions of $y > x/2 + 2$ are points above the second line. Because the solutions to a system of linear inequalities are the points that satisfy all of the inequalities, there are no solutions because no point can be both above $y = x/2 + 2$ and below $y = x/2 - 3$

The main justification aspect of this response is captured by the JE 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.” The response also demonstrates direct evidence of “State definitions, theorems, formulas, or axioms,” “State a property or classification of an object,”

and “State a relationship between two or more objects.” This type of response provides direct evidence for all three levels of justification.

The sample response would receive full credit for successfully creating an argument that uses mathematical claims and definitions to properly explain why the system has no solutions. The response synthesizes the given information with outside knowledge as evidenced by the explanation of what it means to be parallel and what it means to be a solution of a system of linear inequalities. Additionally, 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.

Question 4

The screenshot shows a digital test interface. At the top, there are navigation buttons (back, forward), 'Review', and 'Flag' buttons. The time is 1:20:40 and the user is 'F. Last'. Below the navigation bar, the breadcrumb trail reads 'HOME / MATH EXEMPLARS / SECTION 1 / 4 OF 29'. The main content area is divided into two sections. The left section contains a text problem and a coordinate plane. The text reads: 'A map of Nelson County is laid out in the standard (x,y) coordinate plane below, where the center of the county is at (0,0). A cell phone tower is at (5,4), and Esteban's house is at (10,-2). Each coordinate unit represents 1 mile. The tower's signal range is 10 miles in all directions.' The coordinate plane shows a grid with x and y axes. The origin is labeled 'O'. A point at (5,4) is labeled 'cell phone tower' and a point at (10,-2) is labeled 'Esteban's house'. The right section contains a question: 'How much land area, to the nearest 10 square miles, does the tower's signal range cover?' followed by five multiple-choice options: A. 80, B. 100, C. 310, D. 400, and E. 1,260.

| Sequence | Question type | CCSSM topic | Correct response |
|----------|-------------------|---|------------------|
| 4 | Selected Response | 7.G.B, MP4, Compute the area and circumference of circles after identifying necessary information (G 24–27) | C |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| EHS | Foundation | 2 |

This question is the first of four problems related to common information presented through text and a map. These four questions are independent of each other in that it is not necessary to obtain the correct solution to one question in order to correctly answer any of the other three questions.

Sets of questions like these can provide a richer context and the natural associated challenge in making sense of problems. Sets can provide greater opportunity to make connections within mathematics and to the real world.

Because this set contains questions assessing high school topics, this set would be used on the Early High School test, with this question contributing to the Foundation reporting category and the Modeling reporting category. This question refers to the signal range of a tower. The last sentence of the common information gives details about this range.

Explanation of Correct Response

To solve this question, students must know how to compute the area of a circle (CCSSM.7.G.B.4). More importantly, they must first understand that a circle is central to answering the question. When students attempt to interpret the phrase “10 miles in all directions,” this is modeling (MP4). Students produce the model, a circle of radius 10 miles, and then they can find the area. Answer option C is the correct answer. This question has a DOK level of 2.

Incorrect answers often reflect specific misconceptions. Students who select answer option B, for example, may have computed the area of a square with side length 10 miles, thinking that “10 miles in all directions” meant 10 miles up and 10 miles across. Students who select answer option A may think that 10 miles is the distance across the circle or do not understand the formulas they are using.

Question 5

← →

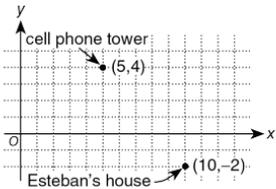
Review Flag

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1:19:26 | F. Last 👤

HOME / MATH EXEMPLARS / SECTION 1 / 5 OF 29

A map of Nelson County is laid out in the standard (x,y) coordinate plane below, where the center of the county is at $(0,0)$. A cell phone tower is at $(5,4)$, and Esteban's house is at $(10,-2)$. Each coordinate unit represents 1 mile. The tower's signal range is 10 miles in all directions.



The strength of the tower's signal to Esteban's house depends on the straight-line distance between his house and the tower. What is the straight-line distance, in miles, between Esteban's house and the tower?

- A. $\sqrt{11}$
- B. $\sqrt{17}$
- C. $\sqrt{29}$
- D. $\sqrt{41}$
- E. $\sqrt{61}$

| Sequence | Question type | CCSSM topic | Correct response |
|----------------------------|--|---|------------------|
| 5 | Selected Response | 8.G.B, Use the distance formula (G 28–32) | E |
| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | | DOK level |
| EHS | Grade Level Progress > Geometry | | 2 |

This question is the second of four problems related to common information. This question asks students to find the distance between 2 points in the standard (x,y) coordinate plane (CCSSM.8.G.B.8). This question is part of the Grade Level Progress reporting category and the Geometry reporting category within that category.

Explanation of Correct Response

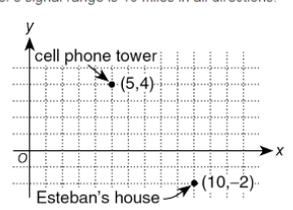
Students can draw a right triangle whose hypotenuse is the line segment connecting the point representing Esteban's house, $(10,-2)$, and the cell phone tower, $(5,4)$, and then use the Pythagorean theorem to solve for the length of that line segment. An equivalent approach is to use the Pythagorean theorem as captured by the distance formula, substituting the values of the coordinates into the formula to evaluate the answer, which is given in E. Both approaches are DOK level 2 skills for the Early High School test.

Question 6

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Review Flag
1:18:30 | F. Last

HOME / MATH EXEMPLARS / SECTION 1 / 6 OF 29

A map of Nelson County is laid out in the standard (x,y) coordinate plane below, where the center of the county is at $(0,0)$. A cell phone tower is at $(5,4)$, and Esteban's house is at $(10,-2)$. Each coordinate unit represents 1 mile. The tower's signal range is 10 miles in all directions.



The tower's signal range directly above a point (a,b) on the ground extends to an altitude, in miles, given by the function $f(a,b) = \sqrt{59 - a^2 + 10a - b^2 + 8b}$. A jet directly above Esteban's house is within the tower's signal range. What is the maximum altitude, in miles, of the jet?

- A. $\sqrt{15}$
- B. $\sqrt{19}$
- C. $\sqrt{39}$
- D. $\sqrt{47}$
- E. $\sqrt{71}$

| Sequence | Question type | CCSSM topic | Correct response |
|----------|-------------------|--|------------------|
| 6 | Selected Response | F-IFA, MP4, Evaluate linear and quadratic functions, expressed in function notation, at integer values (F 20–23) | C |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| EHS | Grade Level Progress > Functions | 2 |

This question is the third of four problems related to common information. In this question, students interpret the given function in the context of the problem, which leads to evaluating the function by finding the appropriate values from the common information and substituting those values into the function (CCSSM.F-IF.A.2). This question is DOK level 2 for the Early High School test and is part of the Functions reporting category within the Grade Level Progress reporting category. This question is also part of the Modeling reporting category, assessing whether students correctly interpret the model in the real-world context.

Explanation of Correct Response

Since the jet is above Esteban's house, and the coordinates of his house are $(10,-2)$, the value of $f(a,b)$ for $a = 10$ and $b = -2$ gives the maximum height at which the plane would receive a signal. This is the value in answer option C. The skills needed for this question build on topics students learned starting in grade 6 (negative numbers) and grade 8 (exponents).

Question 7

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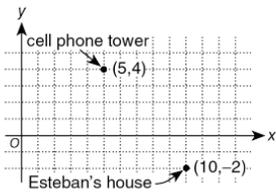
Review Flag

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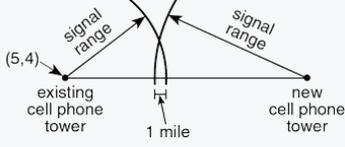
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HOME / MATH EXEMPLARS / SECTION 1 / 7 OF 29

A map of Nelson County is laid out in the standard (x,y) coordinate plane below, where the center of the county is at $(0,0)$. A cell phone tower is at $(5,4)$, and Esteban's house is at $(10,-2)$. Each coordinate unit represents 1 mile. The tower's signal range is 10 miles in all directions.



Star Wireless will add a new cell phone tower, represented by a point on the same horizontal line and to the right of the existing tower. The signal range from the new tower will be 15 miles in all directions. The signal range from the new tower and the signal range from the existing tower will have an overlap of 1 mile along the line connecting the 2 towers (shown below).



Identify an equation of the circle whose interior represents the signal range of the new tower, and refer to the towers as you explain the procedure you used to identify the equation.

(Note: In the standard (x,y) coordinate plane, a circle with center (h,k) and radius r is the graph of the equation $(x-h)^2 + (y-k)^2 = r^2$.)

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| Sequence | Question type | CCSSM topic | Correct response |
|----------|---|---|------------------|
| 7 | Justification & Explanation (Constructed Response) | G.GPE.A, MP1, MP3, MP4, Build functions and write expressions, equations, and inequalities for common algebra settings (e.g., distance to a point on a curve and profit for variable cost and demand) (A 28–32) | See explanation. |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | JE level | DOK level |
|----------------------------|--|----------|-----------|
| EHS | Grade Level Progress > Geometry | 2 | 3 |

This problem is the fourth and final problem of a set of problems related to common information. This task prompts students to explain their reasoning and tie it to a real-world problem. The content here is the general equation of a circle in the standard (x,y) coordinate plane, a high school geometry topic (CCSSM.G.GPE.A). A successful student will make sense of the real-world problem and persevere in solving it, modeling a real-world construct (signal range) in the standard (x,y) coordinate plane (MP1 and MP4). The Justification and Explanation part of the task relates to MP3.

For the Early High School test, this task would be a part of the Geometry reporting category within the Grade Level Progress reporting category for EHS. This task is part of the Justification and Explanation reporting category and requires JE level 2 reasoning. It is a DOK level 3 task.

Explanation of Correct Response

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

The center of the circle is the location of the point that represents the new cell phone tower. The y -coordinate of the center of the circle is 4 because the new cell phone tower lies on the same horizontal line as (5,4). To find the x -coordinate of the center, add 10, the distance the existing cell phone tower can broadcast, to 5, the location of the original cell phone tower, and then add 15 because this is the distance the new cell phone tower can broadcast, and then subtract 1 because of the overlap of the ranges. So the center is at $(5 + 10 + 15 - 1, 4)$ or (29,4). The radius of the circle is the range of the new cell phone tower, which is 15. The resulting equation is $(x - 29)^2 + (y - 4)^2 = 15^2$.

This response is built around the JE statements “State one or more steps in a procedure” and “Explain why a step in a procedure is necessary.” For example, a step in the procedure is “add 10” and the reason to add 10 is that this is “the distance the existing cell phone tower can broadcast.” This response also demonstrates “State a property or classification of an object,” “State a relationship between two or more objects,” and “Use two or more Specific Statements to draw a Conclusion and provide Specific Support for at least one of the Statements.” This type of response provides direct evidence for JE level 1 and JE level 2, which is all that is required to successfully address the task. Some students may use an argument that involves JE level 3 reasoning, and for the purposes of scoring, this would be counted as equal to the response given above because JE level 3 reasoning is not required.

This response successfully accomplishes what the task requires: determining an equation of a circle whose interior represents the signal range of the new tower, and explaining the procedure used to identify the equation. This response shows understanding of the given information, uses logically consistent reasons to support mathematical claims, and expresses the argument in a clear, organized manner.

Question 8

| Sequence | Question type | CCSSM topic | Correct response |
|----------------------------|--|---|---|
| 8 | Technology Enhanced | 8.NS.A, Apply the fact that π is irrational and that the square root of an integer is rational only if that integer is a perfect square (N 28–32) | <input checked="" type="checkbox"/> $\sqrt{2}$ <input checked="" type="checkbox"/> $\sqrt{4}$ <input checked="" type="checkbox"/> $\sqrt{8}$ <input checked="" type="checkbox"/> $\sqrt{16}$ <input checked="" type="checkbox"/> $\sqrt{32}$ <input checked="" type="checkbox"/> $\sqrt{64}$ <input checked="" type="checkbox"/> $\sqrt{128}$ <input checked="" type="checkbox"/> $\sqrt{256}$ |
| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | | DOK level |
| 8 | Grade Level Progress > The Number System | | 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.

Explanation of 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.

Question 9

HOME / MATH EXEMPLARS / SECTION 1 / 9 OF 29

1:16:07 | F. Last

Review Flag

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 .

input x function machine $y = x^2 + 3x - 2$ output y

0 1 2 7 8 9

| Sequence | Question type | CCSSM topic | Correct response |
|----------|---------------------|---|------------------|
| 9 | Technology Enhanced | 8.F.A, Evaluate linear and quadratic functions, expressed in function notation, at integer values (F 20–23) | |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 8 | Grade Level Progress > Functions | 2 |
| EHS | Foundation | 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 test.

Explanation of Correct Response

Evaluating the expression inside the function machine at each of the 6 listed values will show that only 2 of the 6 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 the 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.

Question 10

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 |

| Sequence | Question type | CCSSM topic | Correct response |
|----------|---------------------|--|------------------|
| 10 | Technology Enhanced | 7.SP.C, MP4, Apply counting techniques (S 28–32) | See explanation. |

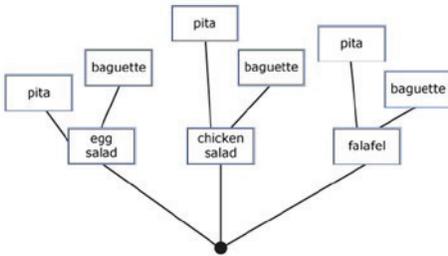
| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 7 | Grade Level Progress > Statistics & Probability | 2 |
| 8, EHS | Foundation | 2 |

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 Foundation reporting category and the Modeling reporting category.

Explanation of 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



Question 11

← → Review Flag 1:15:08 | F. Last

HOME / MATH EXEMPLARS / SECTION 1 / 11 OF 29

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.

1200

| Sequence | Question type | CCSSM topic | Correct response |
|----------|---|---|------------------|
| 11 | Justification & 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) | Foundation and Grade Level Progress reporting categories | JE level | DOK level |
|----------------------------|--|----------|-----------|
| 6 | Grade Level Progress > Geometry | | 3 |
| 7–EHS | Foundation | | 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 4 parts and 1 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 Geometry reporting category (CCSSM.6.G.A) within 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 Foundation 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.

Explanation of Correct Response

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 objects," and "Provide a computation."

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.

Question 12

← →

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1:14:37 | F. Last

HOME / MATH EXEMPLARS / SECTION 1 / 12 OF 29

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

| Sequence | Question type | CCSSM topic | Correct response |
|----------|---------------------|--|------------------|
| 12 | 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) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 7–8 | Foundation | 3 |
| EHS | Foundation | 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.

Explanation of 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 4, 5, 6, 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 Foundation reporting category for the Grade 7 test.

Question 13

HOME / MATH EXEMPLARS / SECTION 1 / 13 OF 29

1:59:21 | F. Last

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

| Sequence | Question type | CCSSM topic | Correct response |
|----------|---------------------|--|------------------|
| 13 | 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) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 7 | Grade Level Progress > Geometry | 2 |
| 8, EHS | Foundation | 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 Foundation reporting category if 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.

Explanation of 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.

Question 14

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1:13:29 | F. Last

HOME / MATH EXEMPLARS / SECTION 1 / 14 OF 29

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. $3.6(1 + 0.05)$

| Sequence | Question type | CCSSM topic | Correct response |
|----------|-------------------|--|------------------|
| 14 | 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) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 7 | Grade Level Progress > Expressions & Equations | 2 |
| 8, EHS | Foundation | 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 Foundation reporting category for the Grade 8 and the Early High School tests.

Explanation of 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.

Question 15

| Sequence | Question type | CCSSM topic | Correct response |
|----------|---------------------|---|------------------|
| 15 | Technology Enhanced | 7.RPA, 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) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 7 | Grade Level Progress > Ratios & Proportional Relationships | 3 |
| 8, EHS | Foundation | 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 Foundation reporting category on the Grade 8 and Early High School tests.

Explanation of 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.

Question 16

Review Flag

1:12:34 | F. Last

HOME / MATH EXEMPLARS / SECTION 1 / 16 OF 29

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.

| Sequence | Question type | CCSSM topic | Correct response |
|----------|-------------------|---|------------------|
| 16 | 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) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 7 | Grade Level Progress > Expressions & Equations | 3 |
| 8, EHS | Foundation | 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).

Explanation of 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 Foundation reporting category. Students produce an inequality to model the situation, and this question is part of the Modeling reporting category.

Question 17

HOME / MATH EXEMPLARS / SECTION 1 / 17 OF 29

1:12:01 | F. Last

The principal of a school must buy 19 desks for a new classroom. Each desk costs \$61. A student calculates the total cost of the desks using the thought process below:

20 desks at \$60 each would cost \$1,200.
 So 19 desks at \$60 each would cost $\$1,200 - \60 .
 Because the price of 1 desk is \$61 and NOT \$60, I must add \$1.
 So the total cost is $\$1,200 - \$60 + \$1$.

- Identify any mistakes in the student's thought process.
- Write an expression that represents the total cost of the 19 desks, and explain why it is correct.

1200

| Sequence | Question type | CCSSM topic | Correct response |
|----------|--|-------------|------------------|
| 17 | Justification & Explanation (Constructed Response) | 4.OA.A, MP3 | See explanation. |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | JE level | DOK level |
|----------------------------|--|----------|-----------|
| 4 | Grade Level Progress > Operations & Algebraic Thinking | 2 | 3 |

This Justification and Explanation task assesses students’ ability to identify an error, develop a correct expression, and explain why the expression is correct. This task elicits two key justification elements: creating an argument with supporting statements and identifying procedural errors. A successful student will demonstrate both the ability to solve word problems involving numeric operations (CCSSM.4.OA.A) and the ability to critique the reasoning of others (MP3).

For grade 4 students, this task would be a part of the Operations and Algebraic Thinking reporting category within the Grade Level Progress reporting category. The task is part of the JE reporting category and requires JE level 2 reasoning. It is a DOK level 3 task. A student interprets and makes a judgment about a numerical model, produces a model, and provides an interpretation to support that the model is correct. This task contributes to the Modeling reporting category.

Explanation of Correct Response

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

The student correctly calculated that $\$1200 - \60 is the cost of 19 desks at \$60 each, but incorrectly thinks that adding just \$1 to that total would be the cost of 19 desks at \$61 each. There are 19 desks, so the student should have added $\$1 \times 19$, which is \$19, to the cost of 19 desks at \$60 each in order to get the cost of 19 desks at \$61 each. The correct expression for the total is $\$1,200 - \$60 + \$1 \times 19$.

The main focus of the justification in this response is the JE statement “Indicate an error occurred” and “Use a specific Statement to draw a Conclusion or provide Specific Support for a Statement.” There is also direct evidence of “State one or more steps in a procedure,” “State a property or classification of an object,” and “Provide a computation.”

The response successfully completes the task by identifying the mistakes in the thought process of the student in the problem, writing the correct expression, and thoroughly explaining why the expression is correct. The response demonstrates understanding and presents an argument that is cohesive, well organized, and accurate.

Question 18

← → Review Flag 1:11:20 | F. Last

HOME / MATH EXEMPLARS / SECTION 1 / 18 OF 29

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

| | | | | | |
|---|---|---|---|---|---|
| | | | x | x | |
| | | x | x | x | |
| x | x | x | x | x | x |
| | | | | | |
| 3 | 1 | 5 | 3 | 7 | |
| 8 | 2 | 8 | 4 | 8 | |

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. $\frac{51}{8}$

| Sequence | Question type | CCSSM topic | Correct response |
|----------|-------------------|---|------------------|
| 18 | 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) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 6 | Grade Level Progress > Statistics & Probability | 3 |
| 7–EHS | Foundation | 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 Foundation component for the Grades 7, 8, and Early High School tests as a DOK level 2 question.

Explanation of Correct Response

The key for this question is 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).

Question 19

| Sequence | Question type | CCSSM topic | Correct response |
|----------|---|------------------|------------------|
| 19 | Justification & Explanation (Constructed Response) | 5.NF.B, MP3, MP4 | See explanation. |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | JE level | DOK level |
|----------------------------|--|----------|-----------|
| 5 | Grade Level Progress > Number & Operations—Fractions | 3 | 3 |
| 6–8 | Foundation | 3 | 3 |
| EHS | Foundation | 2 | 3 |

This questions 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 Number and Operations—Fractions reporting category within 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 Foundation 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.

Explanation of Correct Response

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 those 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.”

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.

Question 20

← → Review Flag 1:10:25 | F. Last

HOME / MATH EXEMPLARS / SECTION 1 / 20 OF 29

Mario and Jenna each drew a circle. Mario divided his circle in half. Jenna divided her circle into twice as many equal sections as Mario's circle.

Select the word below that names the fraction Jenna divided her circle into, and select **all** of the figures below that could represent Jenna's circle.

thirds halves three

four two fourths

| Sequence | Question type | CCSSM topic | Correct response |
|----------|---------------------|-------------|---|
| 20 | Technology Enhanced | 2.G.A, MP4 | <p>thirds halves three</p> <p>four two fourths</p> |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 3–6 | Foundation | 2 |

This technology-enhanced question involves partitioning circles and using correct terms to describe that partitioning (CCSSM.2.G.A.3). This problem is part of the Foundation reporting category for the Grades 3, 4, 5, and 6 tests, and it assesses DOK level 2 skills on each of those tests. Students must judge the appropriateness of each shape as a model for the situation. This problem is a part of the Modeling reporting category.

Explanation of Correct Response

Students must translate the description given in the problem and connect that to mathematical words and figures. Students who do this correctly will find that Jenna divided her circle into fourths.

Question 21

Which of the following amounts of time is the same as $5\frac{3}{4}$ hours?

- A. 5 hours 15 minutes
- B. 5 hours 35 minutes
- C. 5 hours 40 minutes
- D. 5 hours 45 minutes
- E. 5 hours 75 minutes

| Sequence | Question type | CCSSM topic | Correct response |
|----------|-------------------|------------------|------------------|
| 21 | Selected Response | 5.MD.A, MP2, MP4 | D |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 5 | Grade Level Progress > Measurement & Data | 1 |

This selected-response question provides evidence that the student has developed the skill of converting units within a measurement system (CCSSM.5.MD.A). The student must demonstrate quantitative reasoning skills by considering the units involved (MP2) and converting to the appropriate measure.

Converting between units of time is considered to be a routine concept for grade 5 and is therefore considered to be DOK level 1. This question is part of the Measurement and Data reporting category within the Grade Level Progress reporting category for the Grade 5 test, and since it is DOK level 1, this particular question would not appear as Foundation on any other grade level test (the skill may be a part of what is required for a deeper question). For grade 5, the numerical model that students use to make the computation is counted as a part of the Modeling reporting category.

Explanation of Correct Response

The student must translate $\frac{3}{4}$ of an hour to $\frac{3}{4}$ of 60 minutes, obtaining answer option D.

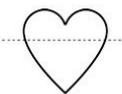
Question 22

← → Review Flag

HOME / MATH EXEMPLARS / SECTION 1 / 22 OF 29

1:09:32 | F. Last

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.



1000

| Sequence | Question type | CCSSM topic | Correct response |
|----------|---|-------------|------------------|
| 22 | Justification & Explanation (Constructed Response) | 4.G.A, MP4 | See explanation. |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | JE level | DOK level |
|----------------------------|--|----------|-----------|
| 4 | Grade Level Progress > Geometry | 3 | 3 |
| 5–7 | Foundation | 3 | 3 |
| 8, EHS | Foundation | 2 | 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 Geometry reporting category within 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 Foundation and the JE reporting categories. The reasoning skills assessed by this task are at JE level 3 for grades 4–7 and JE level 2 for grade 8 and 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).

Explanation of Correct Response

The reasoning in the following sample response is within reach of grade 4 students and would receive full credit.

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.”

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. Note that the definition provided in this response may not be adequate for higher grade levels.

Question 23

| Sequence | Question type | CCSSM topic | Correct response |
|----------|---|------------------|------------------|
| 23 | Justification & Explanation (Constructed Response) | 3.MD.A, MP1, MP3 | See explanation. |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | JE level | DOK level |
|----------------------------|--|----------|-----------|
| 3 | Grade Level Progress > Measurement & Data | 3 | 3 |
| 4–6 | Foundation | 3 | 3 |

This Justification and Explanation task asks students not just to find a solution, but to explain the procedure that leads to that solution. Successful students will explain how they solved the problem and give reasons why their solution is correct. Procedure, computation, and logical flow justification are a few of the justification skills this task elicits. The content here is addition and subtraction of time intervals (CCSSM.3.MD.A). This problem enables students to relate the mathematics they learn in the classroom to their everyday experience. A successful student will make sense of the problem and persevere in solving it (MP1). Students are doing modeling by simulating the events and connecting them to the time each takes. This level of modeling is a part of the Modeling reporting category for grade 3 but not for higher grades.

For grade 3 students, this task would be a part of the Measurement and Data reporting category within the Grade Level Progress reporting category. This task would also be appropriate for the Grades 4, 5, or 6 tests. However, it would be a part of the Foundation reporting category for those tests. At these grade levels, this task requires JE level 3 reasoning and is part of the JE reporting category; the task also is a DOK level 3 task.

Explanation of Correct Response

The reasoning in the following sample response is within reach of a grade 3 student and would receive full credit.

$$30 + 10 + 30 = 70 \text{ min}$$

$$70 - 60 = 10$$

$$70 \text{ min} = 1 \text{ hr } 10 \text{ min}$$

$$1 \text{ hr } 10 \text{ min} = 6:50 \text{ a.m.}$$

Cammy must wake up at 6:50 a.m. so she is not late for school. I know my answer is correct because Cammy has to be at school at 8 and you need to figure how much time it takes to get ready and get to school. I added the times for dressing, eating, and driving to school to get 70 minutes. Then, I subtracted the time needed from the school's start time to find when Cammy needs to get up.

Describing the computational procedure and its results can make an argument more clear, so ACT Aspire captures when students utilize those types of justification techniques. The main JE statements captured in this response are "Provide a computation and reference the computation in one's prose to clarify an argument," "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." The response also provides direct evidence of "Provide a computation," "State a relationship between two or more objects," and "State one or more steps in a procedure." A response of this type demonstrates direct evidence for all three levels of justification.

This response successfully completes the assigned task by finding the time that Cammy has to wake up and by thoroughly supporting that answer. The response demonstrates understanding of the given information and the goal. The student's calculations are evidence that the student understands a procedure required to complete the task successfully, and the explanation is presented clearly and is well organized.

Question 24

← → Review Flag

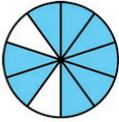
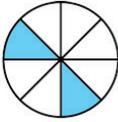
HOME / MATH EXEMPLARS / SECTION 1 / 24 OF 29

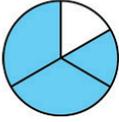
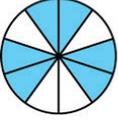
1:08:38 | F. Last

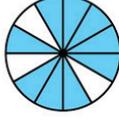
Juliana divided the part of a number line from 0 to 1 into sections of equal length. She plotted point M on the number line, as shown below.

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. 

| Sequence | Question type | CCSSM topic | Correct response |
|----------|-------------------|--|------------------|
| 24 | Selected Response | 3.MFA, MP4, Recognize equivalent fractions and fractions in lowest terms (N 13–15) | E |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 3 | Grade Level Progress > Number & Operations—Fractions | 3 |
| 4–5 | Foundation | 3 |
| 6–EHS | Foundation | 2 |

In this selected-response 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).

Explanation of Correct Response

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

Question 25

← → Review Flag

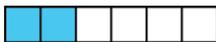
HOME / MATH EXEMPLARS / SECTION 1 / 25 OF 29

1:08:10 | F. Last

A total of 8 students decorated the front surface of 2 different bulletin boards, 1 in the computer lab and 1 in the library.

The computer lab bulletin board has 4 sides and 4 right angles and is 10 feet long and 9 feet tall.

The library bulletin board is divided into 6 equal parts, as shown below, and is shaded to show the fraction of the front surface the students finished decorating on Tuesday.



What is the area, in square feet, of the front surface of the **computer lab** bulletin board?

A. 19

B. 38

C. 76

D. 90

E. 94

| Sequence | Question type | CCSSM topic | Correct response |
|----------|-------------------|---|------------------|
| 25 | Selected Response | 3.MD.C, Compute the area of rectangles when whole number dimensions are given (G 16–19) | D |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 3 | Grade Level Progress > Measurement & Data | 1 |

This question is the first of four problems related to common information. These four problems are independent of each other in that it is unnecessary to obtain the correct solution to one question in order to answer any of the other three questions.

Explanation of Correct Response

In this question, students must recognize that the computer lab bulletin board is a rectangle, given the unequal side lengths, the number of right angles, and the number of sides of the board. Knowing this, students can recall the elementary area formula for a rectangle to arrive at a final answer (CCSSM.3.MD.C.7). Recognizing that the bulletin board is a rectangle from the given information about sides and angles, students will compute $10(9)$ to find the area of the board, answer option D. Computing this area with the given information is a DOK level 1 skill.

Incorrect answers to selected-response questions can give possible insight into misconceptions in student reasoning. Students who select 19 as the answer, for example, may have used addition instead of multiplication to compute the area.

Question 26

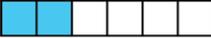
← → Review Flag 1:07.44 | F. Last

HOME / MATH EXEMPLARS / SECTION 1 / 26 OF 29

A total of 8 students decorated the front surface of 2 different bulletin boards, 1 in the computer lab and 1 in the library.

The computer lab bulletin board has 4 sides and 4 right angles and is 10 feet long and 9 feet tall.

The library bulletin board is divided into 6 equal parts, as shown below, and is shaded to show the fraction of the front surface the students finished decorating on Tuesday.



Each student decorated one or the other of the bulletin boards. More students decorated the computer lab bulletin board than the library bulletin board. Which of the following numbers could be the fraction of students who decorated the computer lab bulletin board?

A. $\frac{1}{3}$

B. $\frac{1}{5}$

C. $\frac{4}{8}$

D. $\frac{4}{5}$

E. $\frac{5}{8}$

| Sequence | Question type | CCSSM topic | Correct response |
|----------|-------------------|-------------|------------------|
| 26 | Selected Response | 3.NF.A, MP4 | E |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 3 | Grade Level Progress > Number & Operations—Fractions | 2 |

This question is the second of four problems related to common information. In this question, students must represent quantities as proper fractions (CCSSM.3.NF.A.1) in an applied setting. Students must be able to relate the comparison of the number of students who decorated each board (sentence 2 in the question) to the total number of students who decorated the boards (sentence 1 of the common information).

Explanation of Correct Response

Students can take various approaches from here to arrive at the correct solution. Knowing that more than half of the 8 students decorated the computer lab bulletin board, a student can conclude that either 5, 6, or 7 of the students decorated the computer lab bulletin board. The only answer option that is equivalent to $\frac{5}{8}$, $\frac{6}{8}$, or $\frac{7}{8}$ is E. Other students might interpret the comparison of the number of students to say, “The fraction of students decorating the computer lab bulletin board must be greater than $\frac{1}{2}$.” From there, these students could use their knowledge of fraction equivalence to select from the two fractions whose values exceed $\frac{1}{2}$, which limits the possible answer options to D and E. Answer option D can be eliminated because the product of it and the number of students is not equal to a whole number. These approaches demonstrate DOK level 2 skills. Students are interpreting a model and judging fit, so this question contributes to the Modeling reporting category (MP4).

Question 27

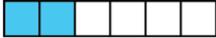
← → Review Flag

HOME / MATH EXEMPLARS / SECTION 1 / 27 OF 29 1:04:43 | F. Last

A total of 8 students decorated the front surface of 2 different bulletin boards, 1 in the computer lab and 1 in the library.

The computer lab bulletin board has 4 sides and 4 right angles and is 10 feet long and 9 feet tall.

The library bulletin board is divided into 6 equal parts, as shown below, and is shaded to show the fraction of the front surface the students finished decorating on Tuesday.



Select all the words below that **must** describe the shape of the front surface of the **computer lab** bulletin board.

square rectangle quadrilateral rhombus parallelogram

| Sequence | Question type | CCSSM topic | Correct response |
|----------|---------------------|-------------|--|
| 27 | Technology Enhanced | 3.G.A, MP4 | square rectangle quadrilateral rhombus parallelogram |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 3 | Grade Level Progress > Geometry | 2 |

This problem is the third of four problems related to common information. This problem assesses skills at DOK level 2. Students in grade 3 classify figures of various types; they will use those classifications to help them select an appropriate formula when computing areas and perimeters of those figures in grades 6 and 7.

Explanation of Correct Response

This problem targets the ability of a student to classify a figure based on its properties (CCSSM.3.G.A.1). The board has four sides, making it a quadrilateral. Given that the board has four right angles and a width unequal to its length, it must be more specifically a rectangle. The board can also be classified as a parallelogram, since a rectangle is a specific type of parallelogram. The board is not a rhombus or a square because all of the sides are not the same length. This is a modeling task, where the student must consider the definition of each figure and see if the definition fits the real-world description given in the question, and so this problem contributes to the Modeling reporting category (MP4).

Question 28

← →

Review Flag

1:06:43 | F. Last

HOME / MATH EXEMPLARS / SECTION 1 / 28 OF 29

A total of 8 students decorated the front surface of 2 different bulletin boards, 1 in the computer lab and 1 in the library.

The computer lab bulletin board has 4 sides and 4 right angles and is 10 feet long and 9 feet tall.

The library bulletin board is divided into 6 equal parts, as shown below, and is shaded to show the fraction of the front surface the students finished decorating on Tuesday.



What fraction of the front surface of the **library** bulletin board did the students finish decorating on Tuesday?

Drag numbers below to the boxes to show a correct fraction.

| | | |
|---|---|---|
| 1 | 2 | 3 |
| 4 | 5 | 6 |
| 7 | 8 | 9 |

| Sequence | Question type | CCSSM topic | Correct responses | | | | | | |
|----------|---------------------|-------------|--|---|---|---|---|---|---|
| 28 | Technology Enhanced | 3.G.A, MP4 | <table style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr> <td style="border: 1px solid gray; padding: 2px 5px;">2</td> <td style="border: 1px solid gray; padding: 2px 5px;">1</td> <td style="border: 1px solid gray; padding: 2px 5px;">3</td> </tr> <tr> <td style="border: 1px solid gray; padding: 2px 5px;">6</td> <td style="border: 1px solid gray; padding: 2px 5px;">3</td> <td style="border: 1px solid gray; padding: 2px 5px;">9</td> </tr> </table> | 2 | 1 | 3 | 6 | 3 | 9 |
| 2 | 1 | 3 | | | | | | | |
| 6 | 3 | 9 | | | | | | | |

| Appropriate grade level(s) | Foundation and Grade Level Progress reporting categories | DOK level |
|----------------------------|--|-----------|
| 3 | Grade Level Progress > Geometry | 2 |

This question is the fourth and final problem of a set related to common information.

Explanation of Correct Response

This problem provides evidence of a student’s ability to express the area of part of a figure as a fraction (CCSSM.3.G.A.2). Such a skill has value in advanced courses like statistics, where the concepts of probability (written as a fraction, decimal, or percent) and area play a large role in solving problems involving normal distributions.

Students must find the relevant information from the common information and translate the picture provided into a fractional representation, a DOK level 2 skill. Producing fractions from the area diagram is a part of the Modeling reporting category at grade 3 (MP4). Giving students a drag-and-drop approach to answer the question allows students to provide any one of three correct solutions: 1/3, 2/6, or 3/9.