pennsylvania
DEPARTMENT OF EDUCATION

PENNSYLVANIA
KEYSTONE EXAMS

Algebra I
Module 1
Item and Scoring Sampler

2024–2025

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INFORMATION ABOUT MATHEMATICS

Introduction

The Pennsylvania Department of Education (PDE) provides districts and schools with tools to assist in delivering focused instructional programs aligned with the Pennsylvania Core Standards (PCS). These tools include the standards, Assessment Anchor documents, Keystone Exams Test Definition, Classroom Diagnostic Tool, Standards Aligned System, and content-based Item and Scoring Samplers. This 2024 Algebra I Item and Scoring Sampler is a useful tool for Pennsylvania educators in preparing students for the Keystone Exams by providing samples of test item types and scored student responses. This Item and Scoring Sampler is not designed to be used as a pretest, a curriculum, or any other benchmark for operational testing.

This Item and Scoring Sampler contains released operational multiple-choice and constructed-response items that have appeared on previously administered Keystone Exams. These items will not appear on any future Keystone Exams. Released items provide an idea of the types of items that have appeared on operational exams and that will appear on future operational Keystone Exams. Each item has been through a rigorous review process to ensure alignment with the Assessment Anchors and Eligible Content. This Item and Scoring Sampler includes items that measure a variety of Assessment Anchor or Eligible Content statements, but it does not include sample items for all Assessment Anchor or Eligible Content statements.

The items in this Item and Scoring Sampler may be used[1] as samples of item types that students will encounter in operational testing. Classroom teachers may find it beneficial to have students respond to the constructed-response items in this Item and Scoring Sampler. Educators may then use this Item and Scoring Sampler as a guide to score the responses either independently or together with colleagues within a school or district.

This Item and Scoring Sampler is available in Braille format. For more information regarding Braille, call (717) 901-2238.

About the Keystone Exams

The Keystone Exams are end-of-course assessments currently designed to assess proficiencies in Algebra I, Biology, and Literature. For detailed information about how the Keystone Exams are being integrated into the Pennsylvania graduation requirements, please contact the Pennsylvania Department of Education or visit the PDE website at https://www.education.pa.gov/.

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[1] The permission to copy and/or use these materials does not extend to commercial purposes.

Alignment

The Algebra I Keystone Exam consists of questions grouped into **two modules**:
Module 1—Operations and Linear Equations & Inequalities and Module 2—Linear Functions and Data Organizations. Each module corresponds to specific content aligned to statements and specifications included in the course-specific Assessment Anchor documents. The Algebra I content included in the Keystone Algebra I multiple-choice items will align with the Assessment Anchors as defined by the Eligible Content statements. The process skills, directives, and action statements will also specifically align with the Assessment Anchors as defined by the Eligible Content statements.

The content included in Algebra I constructed-response items aligns with content included in the Eligible Content statements. The process skills, directives, and action statements included in the performance demands of the Algebra I constructed-response items align with specifications included in the Assessment Anchor statements, the Anchor Descriptor statements, and/or the Eligible Content statements. In other words, the verbs or action statements used in the constructed-response items or stems can come from the Eligible Content, Anchor Descriptor, or Assessment Anchor statements.

Depth of Knowledge

Webb's Depth of Knowledge (DOK) was created by Dr. Norman Webb of the Wisconsin Center for Education Research. Webb's definition of DOK is the cognitive expectation demanded by standards, curricular activities, and assessment tasks. Webb's DOK includes four levels, from the lowest (recall) level to the highest (extended thinking) level.

Level 1—Recall
Level 2—Basic Application of Skill/Concept
Level 3—Strategic Thinking
Level 4—Extended Thinking

Each Keystone item has been through a rigorous review process and is assigned a DOK level. For additional information about DOK, please visit the PDE website at http://static.pdesas.org/content/documents/Keystone_Exams_Understanding_Depth_of_Knowledge_and_Cognitive_Complexity.pdf.

Exam Format

The Keystone Exams are delivered in a paper-and-pencil format as well as in a computer-based online format. The multiple-choice items require students to select the best answer from four possible answer options and record their answers in the spaces provided. The correct answer for each multiple-choice item is worth one point. The constructed-response items require students to develop and write (or construct) their responses. Constructed-response items in Algebra I are scored using item-specific scoring guidelines based on a 0–4-point scale. There are two types of constructed-response items in Algebra I: Extended Constructed Response (ECR) and Short Constructed Response (SCR). ECR items will require students to show or explain their work to support their responses and/or explain their thinking. SCR items will be response only; no support or explanation will be required or scored.

Each multiple-choice item is designed to take about one to one and a half minutes to complete. Each constructed-response item is designed to take about ten minutes to complete. The estimated time to respond to a test question is the same for both test formats. During an official exam administration, students are given additional time as necessary to complete the exam.

Item and Scoring Sampler Format

This Item and Scoring Sampler includes the test directions, scoring guidelines, and formula sheet that appear in the Keystone Exams. Each sample multiple-choice item is followed by a table that includes the item alignment, the answer key, the DOK, the percentage[2] of students who chose each answer option, and a brief answer option analysis or rationale. Each constructed-response item is followed by a table that includes the item alignment, the DOK, and the mean student score. Additionally, each of the included item-specific scoring guidelines is combined with sample student responses representing each score point to form a practical, item-specific scoring guide. The *General Description of Scoring Guidelines for Algebra I* used to develop the item-specific scoring guidelines should be used if any additional item-specific scoring guidelines are created for use within local instructional programs. The student responses in this Item and Scoring Sampler are actual student responses; however, the handwriting has been changed to protect the students' identities and to make this Item and Scoring Sampler accessible to as many people as possible.

Example Multiple-Choice Item Information Table

Category	Item-Specific Information
Alignment	Assigned AAEC
Answer Key	Correct Answer
Depth of Knowledge	Assigned DOK
p-value A	Percentage of students who selected option A
p-value B	Percentage of students who selected option B
p-value C	Percentage of students who selected option C
p-value D	Percentage of students who selected option D
Option Annotations	Brief answer option analysis or rationale

Example Constructed-Response Item Information Table

Category	Item-Specific Information
Alignment	Assigned AAEC
Depth of Knowledge	Assigned DOK
Mean Score	Average Score

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[2] All *p*-value percentages listed in the item information tables have been rounded.

Algebra I Exam Directions

Directions:

Below are the exam directions available to students. These directions may be used to help students navigate through the exam.

Formulas that you may need to solve questions in this module are found on page 9 of this booklet. You may refer to the formula sheet at any time during the exam.

You may use a calculator on this module. When performing operations with π (pi), you may use either calculator π or the number 3.14 as an approximation of π.

There are two types of questions in each module.

Multiple-Choice Questions

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

- First read the question and solve the problem on scratch paper. Then choose the correct answer.

- Only one of the answers provided is correct.

- If none of the choices matches your answer, go back and check your work for possible errors.

- Record your answer in the Algebra I booklet.

Constructed-Response Questions

These questions will require you to write your response.

- These questions have more than one part. Be sure to read the directions carefully.

- Read the items carefully and respond to exactly what is being asked. You will only be given credit by responding to what is requested; you will not be given credit for work that is not requested in the questions.

- You cannot receive the highest score for a constructed-response question without completing all the tasks in the question. For example,

    - if the question asks you to show your work or explain your reasoning, be sure to show your work or explain your reasoning in the space provided.
    - if the question asks you to explain, be sure to use words to explain your reasoning in the space provided.

- All responses must be written in the appropriate location within the response box in the Algebra I booklet. Some answers may require graphing, plotting, labeling, drawing, or shading. If you use scratch paper to write your draft, be sure to transfer your final response to the Algebra I booklet.

If you finish early, you may check your work in Module 1 only.

- <u>Do not look ahead at the questions in Module 2 of your exam materials.</u>

- After you have checked your work, close your exam materials.

You may refer to these directions at any time during this portion of the exam.

General Description of Scoring Guidelines for Algebra I

4 Points

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

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

3 Points

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

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

2 Points

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

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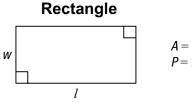
1 Point

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

0 Points

- The response has no correct answer and *insufficient* evidence to demonstrate any understanding of the mathematical concepts and procedures required by the task.
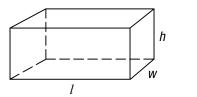
Formula Sheet

Formulas that you may need to solve questions on this exam are found below.
You may use calculator π or the number 3.14 as an approximation of π.

Rectangle

$A = lw$
$P = 2l + 2w$

Rectangular Prism

$V = lwh$

Linear Equations

Slope: $m = \dfrac{y_2 - y_1}{x_2 - x_1}$

Point-Slope Form: $(y - y_1) = m(x - x_1)$

Slope-Intercept Form: $y = mx + b$

Standard Form: $Ax + By = C$

Arithmetic Properties

Additive Inverse: $a + (^-a) = 0$

Multiplicative Inverse: $a \cdot \dfrac{1}{a} = 1$

Commutative Property: $a + b = b + a$
$a \cdot b = b \cdot a$

Associative Property: $(a + b) + c = a + (b + c)$
$(a \cdot b) \cdot c = a \cdot (b \cdot c)$

Identity Property: $a + 0 = a$
$a \cdot 1 = a$

Distributive Property: $a \cdot (b + c) = a \cdot b + a \cdot c$
$a \cdot (b - c) = a \cdot b - a \cdot c$

Multiplicative Property of Zero: $a \cdot 0 = 0$

Additive Property of Equality:
If $a = b$, then $a + c = b + c$

Multiplicative Property of Equality:
If $a = b$, then $a \cdot c = b \cdot c$

ALGEBRA I MODULE 1

Multiple-Choice Items

1. What are **all** the values of *a* that make the inequality $\sqrt{a} > a^2$ true?

Ⓐ $a = 0$

Ⓑ $a > 1$

Ⓒ $0 < a < 1$

Ⓓ $a = 1$

Category	Item-Specific Information
Alignment	A1.1.1.1.1
Answer Key	C
Depth of Knowledge	2
p-value A	8%
p-value B	26%
p-value C	52% (correct answer)
p-value D	14%
Option Annotations	A student could determine the **correct** answer, option C, by recognizing that when the square root of a number between 0 and 1 is determined, the result is larger than the original number (e.g., $\sqrt{0.09}$ = 0.3 > 0.09) and that when the same number is squared, the result is smaller than the original number (e.g., 0.09^2 = 0.0081 < 0.09). So, for numbers between 0 and 1, $\sqrt{a} > a > a^2$. A student could arrive at an **incorrect** answer by finding an instance when the two expressions are equal or by not using substitution to verify the answer choice. For example, a student could arrive at option B by thinking that the square roots of numbers greater than 1 have larger values without substituting any values in for *a* to verify the answer choice, such as substituting *a* = 9 and determining $\sqrt{9}$ = 3 and 9^2 = 81.

2. Which expression can be simplified to the form $x\sqrt{3}$, where x is an integer?

    Ⓐ $\sqrt{48}$

    Ⓑ $\sqrt{51}$

    Ⓒ $\sqrt{54}$

    Ⓓ $\sqrt{57}$

Category	Item-Specific Information
Alignment	A1.1.1.1.2
Answer Key	A
Depth of Knowledge	2
p-value A	62% (correct answer)
p-value B	14%
p-value C	19%
p-value D	5%
Option Annotations	A student could determine the **correct** answer, option A, by recognizing that $x\sqrt{3}$ is the same as $\sqrt{3x^2}$ and then looking for an expression for which the number inside the radical symbol (radicand) is of the form $3x^2$ (i.e., 3 times a perfect square). Of the answer choices, only 48 is of that form, which is $3 \cdot 4^2$. A student could arrive at an **incorrect** answer by finding an instance when the radicand has 3^2 as a factor or has a prime number as a factor rather than a perfect square. For example, a student could arrive at option C by factoring 54 as $3^2 \cdot 6$ and factoring out the 3^2 from the radicand without considering that the factor remaining under the radical symbol (i.e., the resulting radicand) would be a 6 rather than a 3.

3. Which expression is a factor of $x^2 - 2x - 24$?

    Ⓐ $x - 2$

    Ⓑ $x - 4$

    Ⓒ $x - 6$

    Ⓓ $x - 12$

Category	Item-Specific Information
Alignment	A1.1.1.5.2
Answer Key	C
Depth of Knowledge	1
p-value A	19%
p-value B	12%
p-value C	47% (correct answer)
p-value D	22%
Option Annotations	A student could determine the **correct** answer, option C, by factoring the expression $x^2 - 2x - 24$ as $(x-6)(x+4)$, since $4x + {}^-6x = {}^-2x$ (the middle term) and ${}^-6 \cdot 4 = {}^-24$ (the constant term), and then looking through the answer choices for either $x - 6$ or $x + 4$. A student could arrive at an **incorrect** answer by factoring the expression $x^2 - 2x - 24$ incorrectly. For example, a student could arrive at option D by factoring the expression as $(x-12)(x+2)$ by considering that ${}^-12 \cdot 2 = {}^-24$, which is the value of the constant term, and writing the 12 as "minus 12" since the middle term is negative without considering that $2x + {}^-12x = {}^-10x$, which would be the middle term rather than ${}^-2x$.

4. Which expression is equivalent to $\dfrac{2x^2-98}{x^2-14x+49}$ when $x \neq 7$?

  Ⓐ $2(x+7)$

  Ⓑ $\dfrac{1}{7x}$

  Ⓒ $\dfrac{2(x-7)}{x+7}$

  Ⓓ $\dfrac{2(x+7)}{x-7}$

Category	Item-Specific Information
Alignment	A1.1.1.5.3
Answer Key	D
Depth of Knowledge	1
p-value A	12%
p-value B	12%
p-value C	32%
p-value D	44% (correct answer)
Option Annotations	A student could determine the **correct** answer, option D, by rewriting the numerator $2x^2 - 98$ by first factoring out a 2, resulting in $2(x^2 - 49)$, factoring $x^2 - 49$ as a difference of squares, resulting in $2(x - 7)(x + 7)$, rewriting the denominator $x^2 - 14x + 49$ by factoring the expression as $(x - 7)(x - 7)$, and then recognizing that the common factor $x - 7$ cancels out, resulting in $\dfrac{2(x + 7)}{x - 7}$. A student could arrive at an **incorrect** answer by factoring the numerator and/or the denominator incorrectly or by simplifying the factored rational expression incorrectly. For example, a student could arrive at option C by factoring the numerator as $2(x - 7)(x - 7)$ and the denominator as $(x - 7)(x + 7)$ by switching the rules for factoring a difference of squares and factoring an expression that represents the square of a binomial, $(x - a)^2$, and then canceling the common factor $x - 7$, resulting in $\dfrac{2(x - 7)}{x + 7}$.

5. An equation is shown below.

$$\frac{8}{3}x + 48.5 = y$$

Which equation can be used to determine the value of *x* when *y* = 28.1?

Ⓐ $x = \frac{3}{8}(28.1 + 48.5)$

Ⓑ $x = \frac{3}{8}(28.1 - 48.5)$

Ⓒ $x = \frac{8}{3}(28.1 - 48.5)$

Ⓓ $x = \frac{8}{3}(28.1 + 48.5)$

Category	Item-Specific Information
Alignment	A1.1.2.1.1
Answer Key	B
Depth of Knowledge	2
p-value A	11%
p-value B	42% (correct answer)
p-value C	31%
p-value D	16%
Option Annotations	A student could determine the **correct** answer, option B, by substituting 28.1 in for *y*, resulting in $\frac{8}{3}x$ + 48.5 = 28.1, subtracting 48.5 from both sides of the equation, resulting in $\frac{8}{3}x$ = 28.1 − 48.5, and then multiplying both sides of the equation by $\frac{3}{8}$, resulting in $x = \frac{3}{8}(28.1 - 48.5)$. A student could arrive at an **incorrect** answer by incorrectly applying the additive property of equality, the multiplicative property of equality, or both. For example, a student could arrive at option C by first correctly applying the additive property of equality (subtract 48.5 from both sides of the equation), resulting in $\frac{8}{3}x$ = 28.1 − 48.5, but then incorrectly applying the multiplicative property of equality by multiplying the left side of the equation by the reciprocal of $\frac{8}{3}$, which is $\frac{3}{8}$, and the right side by $\frac{8}{3}$, resulting in $x = \frac{8}{3}(28.1 - 48.5)$.

6. One of the steps Neesha used to correctly solve an equation is shown below.

$$\text{line 1:} \quad 18 + 8x - 4 = 13$$

$$\text{line 2:} \quad 8x + 18 - 4 = 13$$

Which set of statements describes the procedure Neesha used to go from line 1 to line 2 and identifies the property that justifies that procedure?

Ⓐ   Neesha changed the order of the 18 and $8x$.
This procedure is justified by the associative property of addition.

Ⓑ   Neesha changed the order of the 18 and $8x$.
This procedure is justified by the commutative property of addition.

Ⓒ   Neesha added -18 to both sides of the equation.
This procedure is justified by the additive inverse property.

Ⓓ   Neesha added -18 to both sides of the equation.
This procedure is justified by the additive property of equality.

Category	Item-Specific Information
Alignment	A1.1.2.1.2
Answer Key	B
Depth of Knowledge	2
p-value A	27%
p-value B	59% (correct answer)
p-value C	9%
p-value D	5%
Option Annotations	A student could determine the **correct** answer, option B, by recognizing that the order of the terms 18 and 8*x* changed and recognizing that when adding the order of the terms may be switched by the commutative property of addition (i.e., *a* + *b* = *b* + *a*). A student could arrive at an **incorrect** answer by incorrectly identifying the change in the equation from line 1 to line 2, identifying the incorrect property, or both. For example, a student could arrive at option A by recognizing that the order of the terms 18 and 8*x* changed but then confusing the associative property of addition [i.e., $(a+b) + c = a + (b+c)$] for the commutative property of addition.

7. Stacy is solving the system of equations shown below.

$$3w + 7t = 64$$

$$6w + 2t = 44$$

Stacy correctly uses elimination to solve the system of equations. Her first step is to rewrite one equation so one of the variables can be eliminated. Which system of equations could show Stacy's rewritten system of equations?

  Ⓐ $-6w + {-14}t = {-128}$
        $6w + 2t = 44$

  Ⓑ $3w + 7t = 64$
        $-3w + {-2}t = {-22}$

  Ⓒ $-6w + {-10}t = {-67}$
        $6w + 2t = 44$

  Ⓓ $3w + 7t = 64$
        $-42w + {-7}t = {-308}$

Category	Item-Specific Information
Alignment	A1.1.2.2.1
Answer Key	A
Depth of Knowledge	2
p-value A	65% (correct answer)
p-value B	16%
p-value C	11%
p-value D	8%
Option Annotations	A student could determine the **correct** answer, option A, by multiplying each term of the first equation of the system by $^-2$, resulting in the equation $^-2 \cdot 3w + ^-2 \cdot 7t = ^-2 \cdot 64$, which simplifies to $^-6w + ^-14t = ^-128$. A student could arrive at an **incorrect** answer by not distributing the multiplier to each term in the equation or by using addition rather than multiplication to affect the coefficients and constant term. For example, a student could arrive at option B by attempting to multiply each side of the second equation by $^-\frac{1}{2}$ without distributing the $^-\frac{1}{2}$ to the second term, resulting in the equation $^-3w + ^-2t = ^-22$ rather than $^-3w + ^-1t = ^-22$.

8. Marcy bought some packages of large paintbrushes and small paintbrushes.

   - Each package of large paintbrushes contained 3 large paintbrushes.

   - Each package of small paintbrushes contained 6 small paintbrushes.

   - She bought a total of 13 packages of paintbrushes.

   - She bought a total of 57 paintbrushes.

   The system of equations shown below can be used to represent this situation.

$$x + y = 13$$

$$3x + 6y = 57$$

   The solution to the system of equations is (7, 6). Based on the solution, which statement is **most likely** true?

   Ⓐ Marcy bought exactly 6 small paintbrushes.

   Ⓑ Marcy bought exactly 6 large paintbrushes.

   Ⓒ Marcy bought exactly 6 packages of small paintbrushes.

   Ⓓ Marcy bought exactly 6 packages of large paintbrushes.

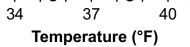| Category	Item-Specific Information
Alignment	A1.1.2.2.2
Answer Key	C
Depth of Knowledge	2
p-value A	15%
p-value B	6%
p-value C	66% (correct answer)
p-value D	13%
Option Annotations	A student could determine the **correct** answer, option C, by recognizing that the $6y$ term in the second equation represents the total number of small paintbrushes Marcy bought since each package of small paintbrushes contains 6 small paintbrushes and then interpreting that the y must therefore represent the number of packages of small paintbrushes Marcy bought. A student could arrive at an **incorrect** answer by misinterpreting what the variables or terms of the equations represent. For example, a student could arrive at option A by recognizing that the y-coordinate represents small paintbrushes but misinterpreting this as the number of small paintbrushes Marcy bought rather than the number of packages of small paintbrushes Marcy bought (i.e., confusing the meaning of the y term in the first equation for the meaning of the $6y$ term in the second equation).

9. A yogurt company recommends that its yogurt be stored at 37 degrees Fahrenheit (°F). The company states that the recommended storage temperature can vary by 3°F. The absolute value inequality shown below represents all the recommended storage temperatures (*x*), in degrees Fahrenheit, for the yogurt.

$$|x - 37| \leq 3$$

Which number line represents all the recommended storage temperatures (*x*), in degrees Fahrenheit, for the yogurt?

Ⓐ **Recommended Storage Temperatures**

Temperature (°F)

Ⓑ **Recommended Storage Temperatures**

Temperature (°F)

Ⓒ **Recommended Storage Temperatures**

Temperature (°F)

Ⓓ **Recommended Storage Temperatures**

Temperature (°F)

Category	Item-Specific Information
Alignment	A1.1.3.1.1
Answer Key	D
Depth of Knowledge	1
p-value A	7%
p-value B	16%
p-value C	10%
p-value D	67% (correct answer)
Option Annotations	A student could determine the **correct** answer, option D, either by rewriting the absolute value inequality as a compound inequality, resulting in $^-3 \leq x - 37 \leq 3$, adding 37 to all three terms, resulting in $34 \leq x \leq 40$, interpreting the inclusive inequalities ("less than or equal to") as requiring closed endpoints, and then identifying a number line with closed endpoints at 34 and 40 with the shading between the endpoints OR by recognizing that $x = 37$ should be the midpoint of the solution set since $37 - 37 = 0$, that the solution set should extend from 3 below 37 (34) to 3 above 37 (40), and that the inclusive inequalities require closed endpoints. A student could arrive at an **incorrect** answer by interpreting the 3 as representing the overall amount of variation, using exclusive inequalities (open circles) to represent the solution set, or both. For example, a student could arrive at option B by considering that the 3 represents an overall variation of 3 and identifying an interval centered at 37 with a range of 3 (35.5 to 38.5) rather than a variation of ± 3 (i.e., $37 - 3$ to $37 + 3$).

10. The graph shown below represents the solution set of an inequality.

Which inequality has the solution set represented in the graph?

Ⓐ $-2x + 4 \geq -198$

Ⓑ $-2x + 4 \leq -198$

Ⓒ $-2x - 4 \geq -198$

Ⓓ $-2x - 4 \leq -198$

Category	Item-Specific Information
Alignment	A1.1.3.1.2
Answer Key	D
Depth of Knowledge	2
p-value A	26%
p-value B	16%
p-value C	25%
p-value D	33% (correct answer)
Option Annotations	A student could determine the **correct** answer, option D, either by recognizing the number line represents $x \geq 97$, and solving the inequality by adding 4 to both sides of the inequality, resulting in $^-2x \leq ^-194$, dividing both sides of the inequality by $^-2$ and changing the direction of the inequality symbol, resulting in $x \geq 97$ OR by interpreting the number line as representing $x \geq 97$, recognizing that each answer choice begins with ^-2x and ends with $^-198$, multiplying both sides of the inequality by $^-2$, resulting in $^-2x \leq ^-194$, and then subtracting 4 from both sides of the inequality, resulting in $^-2x - 4 \leq ^-198$. A student could arrive at an **incorrect** answer by not switching the direction of the inequality sign when multiplying by a negative, attempting to add 4 to both sides of the inequality, or both. For example, a student could arrive at option A by not changing the direction of the inequality symbol when multiplying $x \geq 97$ by $^-2$, resulting in $^-2x \geq ^-194$, and then adding 4 to both sides of the inequality, considering $194 + 4 = 198$ rather than $^-194 + ^-4 = ^-198$.

11. Keisha began a new job and decided to save some money. The linear inequality graphed below models the amount of money she plans to save based on her total earnings.
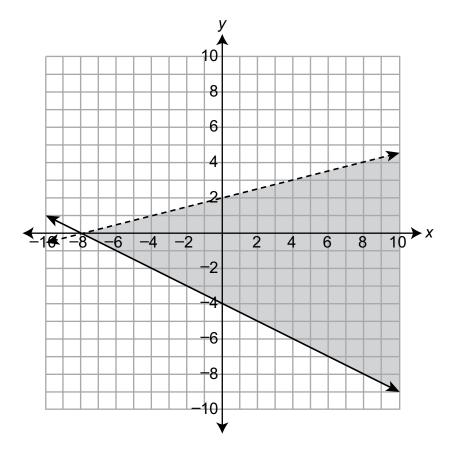
Keisha's Savings Plan

Which statement **best** describes what the point (65, 5) represents?

Ⓐ   When Keisha earns a total of $5, the amount she saves could be exactly $65.

Ⓑ   When Keisha earns a total of $65, the amount she saves could be exactly $5.

Ⓒ   When Keisha earns a total of $5, the amount she saves will be no more than $65.

Ⓓ   When Keisha earns a total of $65, the amount she saves will be no more than $5.

Category	Item-Specific Information
Alignment	A1.1.3.1.3
Answer Key	B
Depth of Knowledge	2
p-value A	8%
p-value B	62% (correct answer)
p-value C	7%
p-value D	23%
Option Annotations	A student could determine the **correct** answer, option B, by recognizing that the point $(65, 5)$ lies within the solution set of the inequality, interpreting the *x*-coordinate as the total amount earned ($65 earned) and the *y*-coordinate as the amount saved ($5 saved), and understanding that there are values greater than the 5 in the solution set when *x* = 65.

A student could arrive at an **incorrect** answer by switching what the variables each represent, considering that a solution must be the maximum amount saved, or both. For example, a student could arrive at option D by interpreting the *x*-coordinate as the total amount earned ($65 earned) and the *y*-coordinate as the amount saved ($5 saved) but then interpreting the solution as though the ordered pair was on the boundary line rather than somewhere else in the shaded region. |

12. The graph shown below represents the solution set for a system of inequalities.

Which system of inequalities has the solution set represented in the graph?

Ⓐ $y \le 0.25x + 2$
     $y \ge {}^-0.5x - 4$

Ⓑ $y \le 0.25x + 2$
     $y > {}^-0.5x - 4$

Ⓒ $y < 0.25x + 2$
     $y \ge {}^-0.5x - 4$

Ⓓ $y < 0.25x + 2$
     $y > {}^-0.5x - 4$

Category	Item-Specific Information
Alignment	A1.1.3.2.1
Answer Key	C
Depth of Knowledge	2
p-value A	9%
p-value B	17%
p-value C	68% (correct answer)
p-value D	6%
Option Annotations	A student could determine the **correct** answer, option C, by recognizing that the dashed line has a slope of $\frac{2-0}{0-{}^-8} = \frac{2}{8} = 0.25$, has a *y*-intercept at $(0, 2)$, and represents an exclusive upper boundary, resulting in the inequality $y < 0.25x + 2$, and that the solid line has a slope of $\frac{{}^-4-0}{0-{}^-8} = \frac{{}^-4}{8} = {}^-0.5$, has a *y*-intercept at $(0, {}^-4)$, and represents an inclusive lower boundary, resulting in the inequality $y \geq {}^-0.5x - 4$. A student could arrive at an **incorrect** answer by interpreting the dashed line as inclusive, interpreting the solid line as exclusive, or both. For example, a student could arrive at option B by interpreting the dashed line as being inclusive, and therefore uses ≤ rather than <, and interpreting the solid line as being exclusive, and therefore uses > rather than ≥.

Constructed-Response Item

13. Perform the indicated tasks.

A. Simplify the expression $\dfrac{x^2 - 3x - 28}{x - 7}$. Write the expression in the simplest form of a polynomial expression.

expression: _____

B. What is the least common multiple (LCM) of $6x^2y^3$ and $10x^3y$?

least common multiple (LCM): _____

Go to the next page to finish question 13.

GO ON ➤

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

C. What is the greatest common factor (GCF) of $12x^3y^5$ and $2x^2y^7$?

greatest common factor (GCF): _____

The expression $\dfrac{x^2 - bx - c}{x + b}$ simplifies to $x - 6$.

D. What is the value of b?

$b =$ _____

GO ON

Item-Specific Scoring Guideline

#13 Item Information

Category	Item-Specific Information
Alignment	A1.1.1
Depth of Knowledge	2
Mean Score	1.12

Assessment Anchor this item will be reported under:

A1.1.1 Operations with Real Numbers and Expressions

Specific Anchor Descriptor addressed by this item:

A1.1.1.1 Represent and/or use numbers in equivalent forms (e.g., integers, fractions, decimals, percents, square roots, and exponents).

A1.1.1.2 Apply number theory concepts to show relationships between real numbers in problem-solving settings.

A1.1.1.3 Use exponents, roots, and/or absolute values to solve problems.

A1.1.1.5 Simplify expressions involving polynomials.

Item-Specific Scoring Guideline

Score	In this item, . . .
4	The student demonstrates a thorough understanding of operations with real numbers and expressions by correctly solving problems with clear and complete procedures and explanations when required.
3	The student demonstrates a general understanding of operations with real numbers and expressions by solving problems and providing procedures and explanations with only minor errors or omissions.
2	The student demonstrates a partial understanding of operations with real numbers and expressions by providing a portion of the correct problem solving, procedures, and explanations.
1	The student demonstrates a minimal understanding of operations with real numbers and expressions.
0	The response has no correct answer and insufficient evidence to demonstrate any understanding of the mathematical concepts and procedures as required by the task. Response may show only information copied from the question.

Top-Scoring Student Response and Training Notes

Score	Description
4	Student earns 4 points.
3	Student earns 3 points.
2	Student earns 2 points.
1	Student earns 1 point.
0	Response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.

Top-Scoring Response

Part A (1 point):

    1 point for correct answer

What?
$x + 4$ **OR** $4 + x$

Part B (1 point):

    1 point for correct answer

What?
$30x^3y^3$

Part C (1 point):

    1 point for correct answer

What?
$2x^2y^5$

Part D (1 point):

1 point for correct answer

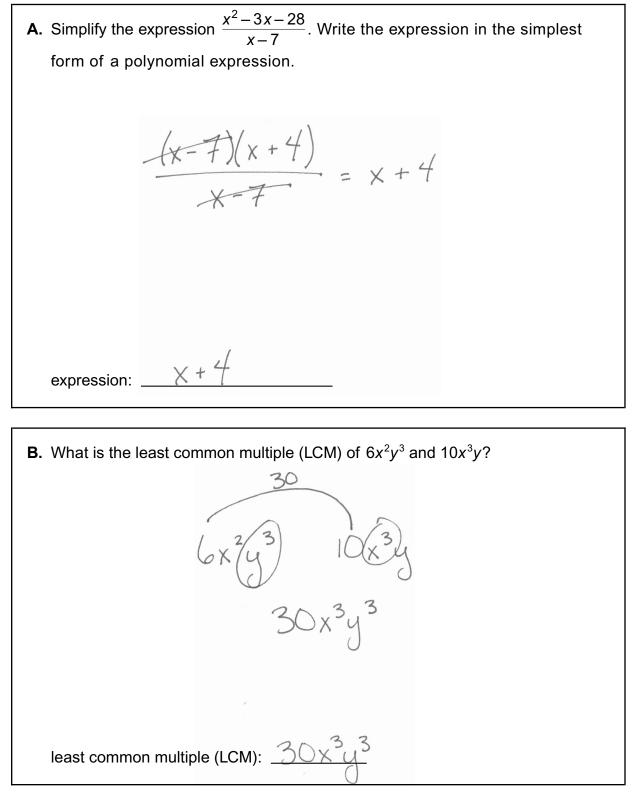| **What?** |
| --- |
| 3 |
| **OR** |
| $\dfrac{6x - c}{2x - 6}$ |
| **OR** |
| Any expression where $c = 18$, $b = 3$ |

STUDENT RESPONSE

Response Score: 4 points

13. Perform the indicated tasks.

A. Simplify the expression $\dfrac{x^2 - 3x - 28}{x - 7}$. Write the expression in the simplest form of a polynomial expression.

$$\frac{\cancel{(x-7)}(x+4)}{\cancel{x-7}} = x + 4$$

expression: ___$x + 4$___

B. What is the least common multiple (LCM) of $6x^2y^3$ and $10x^3y$?

$$30$$
$$6x^2(y^3) \qquad 10(x^3)y$$
$$30x^3y^3$$

least common multiple (LCM): ___$30x^3y^3$___

Go to the next page to finish question 13.   GO ON ▶

Part A: The student provided the correct answer ($x + 4$). The student provided work, although the work is not required or assessed. Based on the work provided, the student correctly factored $\dfrac{x^2 - 3x - 28}{x - 7}$, resulting in $\dfrac{(x-7)(x+4)}{x-7}$, crossed off the common factors in the numerator and the denominator, and then rewrote the expression as $x + 4$. [1 point]

Part B: The student provided the correct answer ($30x^3y^3$). The student provided work, although the work is not required or assessed. The student rewrote $6x^2y^3$ and $10x^3y$, determined that the coefficient of the least common multiple (LCM) is 30 (which can be found by factoring 6 as $2 \cdot 3$ and 10 as $2 \cdot 5$, and then multiplying $2 \cdot 3 \cdot 5 = 30$), and then identified the exponent for the variable x of the LCM by circling the x^3 (from $10x^3y$) and the exponent for the variable y of the LCM by circling the y^3 (from $6x^2y^3$) since these are the larger exponents for each variable. [1 point]

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

C. What is the greatest common factor (GCF) of $12x^3y^5$ and $2x^2y^7$?

$12x^2y$

greatest common factor (GCF): $2x^2y^5$

The expression $\dfrac{x^2 - bx - c}{x + b}$ simplifies to $x - 6$.

D. What is the value of b?

$-c = -6b$
$-c = -18$
$c = 18$

$$\frac{x^2 - bx - c}{x + b} = x - 6$$

$x^2 - bx - c = (x - 6)(x + b)$
$x^2 - bx - c = x^2 + (-(6 + b)x - 6b$
$-bx = (-6 + b)x$
$-b = -6 + b$
$+b \qquad +b$
$\overline{\qquad\qquad}$
$0 = -6 + 2b$
$+6 \quad +6$
$\overline{\qquad\qquad}$
$2b = 6$

$b = 3$

$b = \underline{3}$

GO ON

Part C: The student provided the correct answer ($2x^2y^5$). While support is not required for Part C, the student likely determined that the coefficient of the greatest common factor (GCF) is 2 (which can be found by factoring 12 as $2 \cdot 2 \cdot 3$ and recognizing that 2 is prime, resulting in a GCF of 2 since 2 is the only common factor) and then determined the exponent for the variable x of the GCF (x^2 from $2x^2y^7$) and the exponent for the variable y of the GCF (y^5 from $12x^3y^5$) since these are the smaller exponents for each variable. [1 point]

Part D: The student provided the correct answer (*3*). The student provided work, although the work is not required or assessed. The student rewrote the given information as the equation $\dfrac{x^2 - bx - c}{x + b} = x - 6$, multiplied both sides of the equation by $x + b$, resulting in $x^2 - bx - c = (x - 6)(x + b)$, expanded the right side of the equation, resulting in $x^2 - bx - c = x^2 + (^-(6 + b)x - 6b$, recognized that the x^2 terms on each side of the equation are equal and therefore can be canceled, simplified the equation to $^-bx = (^-6 + b)x$, divided both sides of the equation by x, resulting in $^-b = ^-6 + b$, added b to both sides of the equation, resulting in $0 = ^-6 + 2b$, added 6 to both sides of the equation, resulting in $2b = 6$, and then divided both sides by 2 (not shown) resulting in $b = 3$. [Note: Although the student initially wrote $(^-(6 + b)x$, this was corrected on the next line of work, so the extra parenthesis was viewed as a blemish and did not affect the score.] The student also correctly solved for c ($c = 18$), but this was not required or assessed. [1 point]

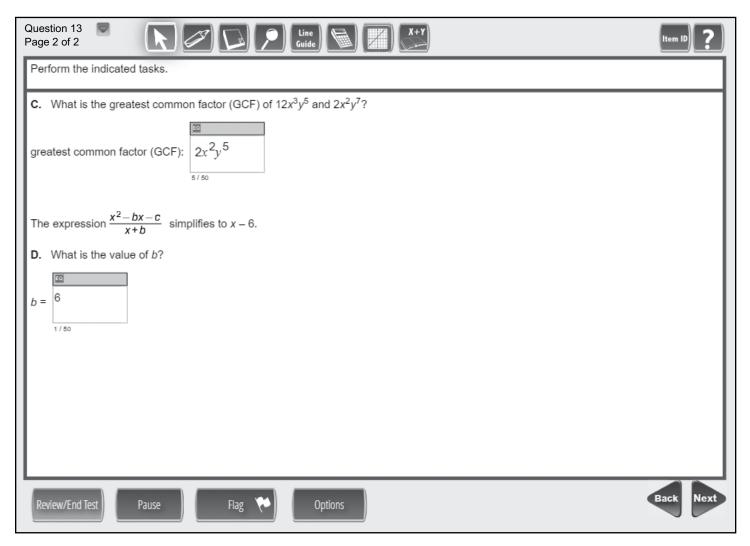**STUDENT RESPONSE**

🖥 **Computer Response Score: 3 points**

PARTS A and B

Question 13
Page 1 of 2

Line Guide   X+Y   Item ID   ?

Perform the indicated tasks.

A. Simplify the expression $\dfrac{x^2 - 3x - 28}{x - 7}$. Write the expression in the simplest form of a polynomial expression.

EQ

expression: $x + 4$

3 / 50

B. What is the least common multiple (LCM) of $6x^2y^3$ and $10x^3y$?

EQ

least common multiple (LCM): $30x^3y^3$

6 / 50

Review/End Test   Pause   Flag 🚩   Options   Next

Part A: The student provided the correct answer ($x + 4$). While support is not required for Part A, the student likely factored the numerator $x^2 - 3x - 28$ as $(x - 7)(x + 4)$ and then canceled the common factor $(x - 7)$ in both the numerator and the denominator, resulting in the simplified expression $x + 4$. [1 point]

Part B: The student provided the correct answer ($30x^3y^3$). While support is not required for Part B, the student may have factored $6x^2y^3$ as $(2 \cdot 3) \cdot (x \cdot x) \cdot (y \cdot y \cdot y)$ and $10x^3y$ as $(2 \cdot 5) \cdot (x \cdot x \cdot x) \cdot (y)$ and then determined the least common multiple (LCM) by combining the factors found in the expressions, using each common factor only once, resulting in $(2 \cdot 3 \cdot 5) \cdot (x \cdot x \cdot x) \cdot (y \cdot y \cdot y)$, which simplifies to $30x^3y^3$. [1 point]

PARTS C and D

Question 13
Page 2 of 2

Line Guide   X+Y   Item ID   ?

Perform the indicated tasks.

C. What is the greatest common factor (GCF) of $12x^3y^5$ and $2x^2y^7$?

EQ

greatest common factor (GCF): $2x^2y^5$

5 / 50

The expression $\dfrac{x^2 - bx - c}{x + b}$ simplifies to $x - 6$.

D. What is the value of b?

EQ

$b = $ 6

1 / 50

Review/End Test   Pause   Flag   Options   Back   Next

Part C: The student provided the correct answer ($2x^2y^5$). While support is not required for Part C, the student likely factored $12x^3y^5$ as $(2 \cdot 2 \cdot 3) \cdot (x \cdot x \cdot x) \cdot (y \cdot y \cdot y \cdot y \cdot y)$ and $2x^2y^7$ as $(2) \cdot (x \cdot x) \cdot (y \cdot y \cdot y \cdot y \cdot y \cdot y \cdot y)$ and then determined the greatest common factor (GCF) by including only those factors that are found in both expressions, resulting in $(2) \cdot (x \cdot x) \cdot (y \cdot y \cdot y \cdot y \cdot y)$, which simplifies to $2x^2y^5$. [1 point]

Part D: The student provided an incorrect answer (6). No support (work or explanation) is required, so it is unclear where an error was made. The student may have written the equation $x^2 - bx - c = (x - 6)(x + b)$, expanded the right side of the equation, resulting in $x^2 - bx - c = x^2 + (^-6 + b)x - 6b$, but then wrote the equation $^-6 + b = 0$ rather than $^-6 + b = ^-b$, resulting in $b = 6$ rather than $b = 3$. [0 points]

STUDENT RESPONSE

Response Score: 2 points

13. Perform the indicated tasks.

A. Simplify the expression $\dfrac{x^2 - 3x - 28}{x - 7}$. Write the expression in the simplest form of a polynomial expression.

expression: $\dfrac{1}{2x - 4}$

B. What is the least common multiple (LCM) of $6x^2y^3$ and $10x^3y$?

least common multiple (LCM): $30x^5y^4$

Go to the next page to finish question 13.

GO ON ▶

Part A: The student provided an incorrect answer $\left(\dfrac{1}{2x-4}\right)$. No support (work or explanation) is required for Part A, so it is unclear where an error was made. The student may have attempted to simplify the expression term by term rather than by factoring. This could have led the student to cancel the x^2 term since there is no x^2 term in the denominator, simplify the ^-3x term divided by the x term as ^-2x, write this term in the denominator to change the negative coefficient to a positive coefficient (i.e., incorrectly apply the rule for negative exponents to negative coefficients), then simplify $^-28$ over $^-7$ as 4, and write this term in the denominator to change the positive value to a negative value. [0 points]

Part B: The student provided an incorrect answer ($30x^5y^4$). No support (work or explanation) is required, so it is unclear where an error was made. The student correctly determined the coefficient of the least common multiple (LCM) to be 30 (which can be found by factoring 6 as $2 \cdot 3$ and 10 as $2 \cdot 5$, and then multiplying $2 \cdot 3 \cdot 5 = 30$); however, the student may have determined the exponents for the variable x of the LCM by adding the exponents for the x variables, resulting in $x^{2+3} = x^5$, and for the variable y of the LCM by adding the exponents for the y variables, resulting in $y^{3+1} = y^4$. [0 points]

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

C. What is the greatest common factor (GCF) of $12x^3y^5$ and $2x^2y^7$?

greatest common factor (GCF): $2x^2y^5$

The expression $\dfrac{x^2 - bx - c}{x + b}$ simplifies to $x - 6$.

D. What is the value of b?

$b = 3$

GO ON

Part C: The student provided the correct answer ($2x^2y^5$). While support is not required for Part C, the student likely determined that the coefficient of the greatest common factor (GCF) is 2 (which can be found by factoring 12 as $2 \cdot 2 \cdot 3$ and recognizing that 2 is prime, resulting in a GCF of 2 since 2 is the only common factor) and then determined the exponent for the variable x of the GCF by identifying the smaller exponent for each x variable (x^2 from $2x^2y^7$) and the exponent for the variable y of the GCF by identifying the smaller exponent for each y variable (y^5 from $12x^3y^5$). [1 point]

Part D: The student provided the correct answer (*3*). While support is not required for Part D, the student may have recognized that the given rational expression is equal to $\dfrac{(x+b)(x-6)}{x+b}$, since the $(x+b)$ factors would cancel, expanded the numerator as $x^2 - 6x + bx - 6b$, combined like terms, resulting in $x^2 + \left(^-6+b\right)x - 6b$, recognized that the x^2 terms on each side of the equation are equal and therefore can be canceled, simplified the equation to $^-b = {}^-6 + b$, added ^-b to both sides of the equation, resulting in $^-2b = {}^-6$, and then divided both sides of the equation by $^-2$, resulting in $b = 3$. [1 point]

STUDENT RESPONSE

🖥 **Computer Response Score: 1 point**

PARTS A and B

Question 13
Page 1 of 2

Perform the indicated tasks.

A. Simplify the expression $\dfrac{x^2 - 3x - 28}{x - 7}$. Write the expression in the simplest form of a polynomial expression.

expression: $\dfrac{-4x^3 - 28}{x - 7}$

7 / 50

B. What is the least common multiple (LCM) of $6x^2y^3$ and $10x^3y$?

least common multiple (LCM): $30x^3y^3$

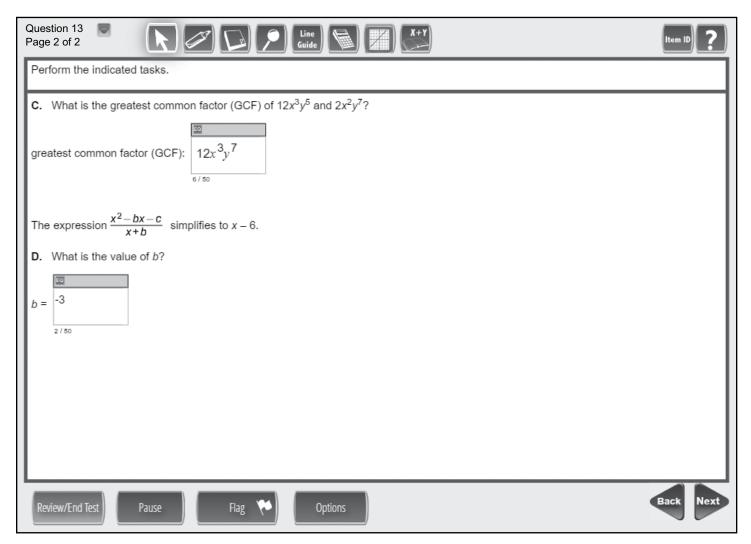6 / 50

Review/End Test   Pause   Flag   Options   Next

Part A: The student provided an incorrect answer $\left(\frac{-4x^3 - 28}{x - 7} \right)$. No support (work or explanation) is required for Part A, so it is unclear where an error was made. The student may have attempted to combine the x^2 term and the ^-3x term into one term by adding the absolute value of the coefficients (1 + 3 = 4), applying the negative sign of the "larger" coefficient, and then adding the exponents (2 + 1 = 3), resulting in $^-4x^3$, while leaving the $^-28$ and the denominator unchanged. [0 points]

Part B: The student provided the correct answer ($30x^3y^3$). While support is not required for Part B, the student may have determined the coefficient of the least common multiple (LCM) by writing the multiples of 6 and 10 until reaching the first common multiple, which is 30 (6, 12, 18, 24, 30 and 10, 20, 30), and then determined the exponent for the variable x of the LCM by identifying the larger exponent for each x variable (x^3 from $10x^3y$) and the exponent for the variable y of the LCM by identifying the larger expoenent for each y variable (y^3 from $6x^2y^3$). [1 point]

PARTS C and D

Question 13
Page 2 of 2

Line Guide   X+Y   Item ID   ?

Perform the indicated tasks.

C. What is the greatest common factor (GCF) of $12x^3y^5$ and $2x^2y^7$?

EQ

greatest common factor (GCF): $12x^3y^7$

6 / 50

The expression $\dfrac{x^2 - bx - c}{x + b}$ simplifies to $x - 6$.

D. What is the value of b?

EQ

$b =$ -3

2 / 50

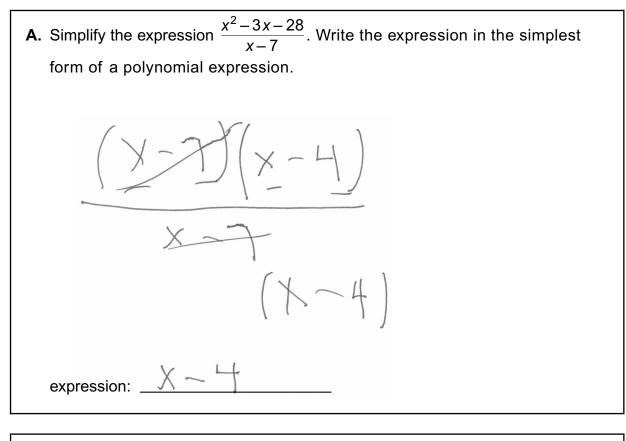Review/End Test   Pause   Flag   Options   Back   Next

Part C: The student provided an incorrect answer ($12x^3y^7$). No support (work or explanation) is required, so it is unclear where an error was made. The student may have determined the least common multiple (LCM) of the two monomials rather than the greatest common factor (GCF) by writing the multiples of 2 and 12 until reaching the first common multiple, which is 12 (2, 4, 6, 8, 10, 12 and 12), rather than writing the factors of 2 and 12 and identifying the common factors, and then by identifying the larger exponent for each variable (x^3 from $12x^3y^5$ and y^7 from $2x^2y^7$) rather than the smaller exponent for each variable. [0 points]

Part D: The student provided an incorrect answer (*-3*). No support (work or explanation) is required, so it is unclear where an error was made. The student may have recognized that the given rational expression is equal to $\dfrac{(x+b)(x-6)}{x+b}$, since the $(x + b)$ factors would cancel, expanded the numerator as $x^2 - 6x + bx - 6b$, combined like terms, resulting in $x^2 + \left(^-6+b\right)x - 6b$, recognized that the x^2 terms on each side of the equation are equal and therefore can be canceled, simplified the equation to $^-b = {}^-6 + b$, added b to both sides of the equation, resulting in $0 = {}^-6 + 2b$, but then moved the $^-6$ to the other side of the equation rather than adding 6 to both sides of the equation, resulting in $^-6 = 2b$, which simplifies to $^-3 = b$ after dividing both sides of the equation by 2. [0 points]
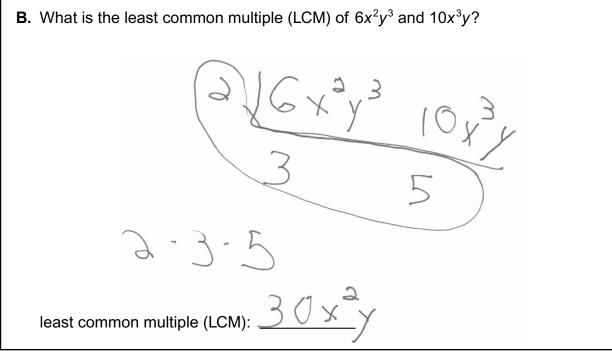
STUDENT RESPONSE

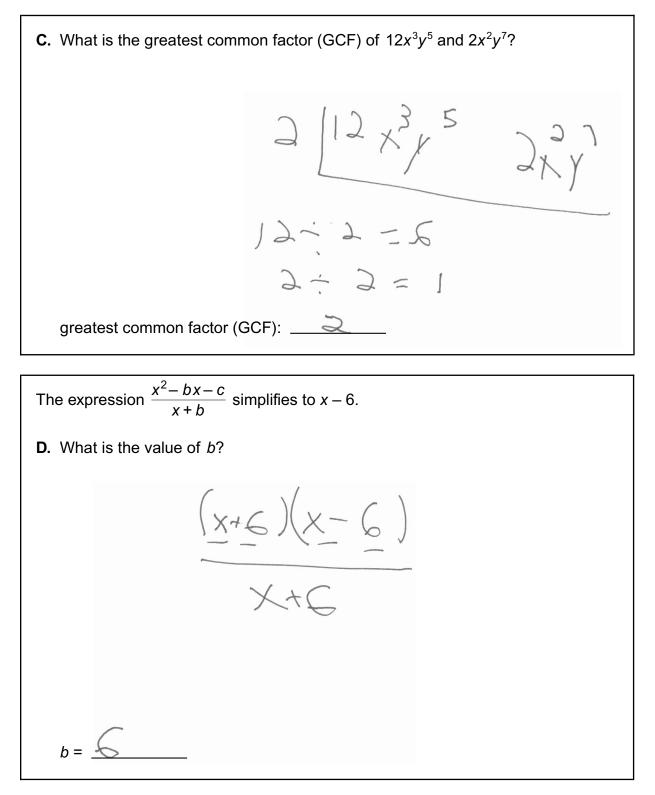**Response Score: 0 points**

13. Perform the indicated tasks.

A. Simplify the expression $\dfrac{x^2 - 3x - 28}{x - 7}$. Write the expression in the simplest form of a polynomial expression.

$$\frac{(x - 7)(x - 4)}{x - 7}$$

$$(x - 4)$$

expression: ___$x - 4$___

B. What is the least common multiple (LCM) of $6x^2y^3$ and $10x^3y$?

$$2\overline{)\,6x^2y^3 \quad 10x^3y}$$
$$\quad\quad 3 \quad\quad\quad\quad 5$$

$$2 \cdot 3 \cdot 5$$

$$30x^2y$$

least common multiple (LCM): ___$30x^2y$___

Go to the next page to finish question 13.

GO ON

Part A: The student provided an incorrect answer ($x - 4$). The student provided work, although the work is not required or assessed. The student incorrectly factored the numerator $x^2 - 3x - 28$ as $(x-7)(x-4)$, using $x - 4$ rather than $x + 4$, crossed off the common factors in the numerator and the denominator, and then rewrote the expression as $(x-4)$. Although the student may have recognized that 7 and 4 have a product of 28 and a difference of 3, the student may have used two subtraction signs in the binomials rather than one addition sign and one subtraction sign since the original numerator had two subtraction signs. [0 points]

Part B: The student provided an incorrect answer ($30x^2y$). The student provided work, although the work is not required or assessed. The student determined the correct coefficient for the least common multiple (LCM) to be 30 by writing the common factor of the coefficients to the left of the two monomials and the unique factors of the monomials below each monomial, resulting in $2 \cdot 3 \cdot 5$, which is equal to 30; however, the student may have switched the rules for determining the LCM and the GCF of variables by using the smaller exponent for each variable (x^2 from $6x^2y^3$ and y from $10x^3y$) rather than the larger exponent for each variable. [0 points]

13. **_Continued._** Please refer to the previous page for task explanation.

C. What is the greatest common factor (GCF) of $12x^3y^5$ and $2x^2y^7$?

$$2\overline{)\,12\,x^3y^5 \qquad 2x^2y^7}$$

$$12 \div 2 = 6$$

$$2 \div 2 = 1$$

greatest common factor (GCF): ___2___

The expression $\dfrac{x^2 - bx - c}{x + b}$ simplifies to $x - 6$.

D. What is the value of b?

$$\frac{(x+6)(x-6)}{x+6}$$

$b = $ ___6___

GO ON

Part C: The student provided an incorrect answer (*2*). The student provided work, although the work is not required or assessed. The student determined the correct coefficient of the greatest common factor (GCF) to be 2 by writing the common factor of the coefficients to the left of the two monomials and confirming there were no further common factors by dividing each coefficient by 2 ($12 \div 2 = 6$ and $2 \div 2 = 1$); however, the student did not determine the GCF of the variables. [0 points]

Part D: The student provided an incorrect answer (*6*). The student provided work, although the work is not required or assessed. The student may have determined the conjugate of $(x - 6)$, which is $(x + 6)$, and multiplied $(x - 6)$ by $\dfrac{x + 6}{x + 6}$, resulting in $\dfrac{(x + 6)(x - 6)}{x + 6}$, without considering that multiplying $(x + 6)$ by $(x - 6)$ actually results in $x^2 - 36$, which would lead to two different values of *b* (0 in the numerator and 6 in the denominator). [0 points]

Constructed-Response Item

14. Andrea and Carter are going on a picnic.

To prepare for the picnic, Andrea buys 4 bags of granola and 3 bags of dried fruit and spends $51.50. Carter buys 2 bags of granola and 4 bags of dried fruit and spends $45.50.

A. Write and solve a system of equations to determine the cost of a bag of granola and the cost of a bag of dried fruit.
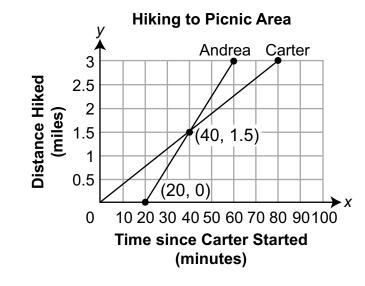
cost of a bag of granola: $ _____

cost of a bag of dried fruit: $ _____

Go to the next page to finish question 14.

GO ON

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

Andrea and Carter will both hike to the picnic area from the park entrance. Carter starts at the park entrance and begins hiking to the picnic area at a constant rate. Andrea starts at the park entrance some time later than Carter and begins hiking toward the picnic area at a different constant rate. The picnic area is 3 miles from the park entrance. The graph below represents this situation.

Hiking to Picnic Area

B. Explain why the graph of Andrea's line starts at (20, 0).

C. Explain what the solution to the system of equations graphed in **part B** represents in the context of this problem.

AFTER YOU HAVE FINISHED YOUR WORK, CLOSE THIS BOOKLET SO YOUR TEACHER WILL KNOW YOU ARE FINISHED.

STOP

Item-Specific Scoring Guideline

#14 Item Information

Category	Item-Specific Information
Alignment	A1.1.2
Depth of Knowledge	3
Mean Score	1.69

Assessment Anchor this item will be reported under:

A1.1.2 Linear Equations

Specific Anchor Descriptor addressed by this item:

A1.1.2.1 Write, solve, and/or graph linear equations using various methods.

A1.1.2.2 Write, solve, and/or graph systems of linear equations using various methods.

Item-Specific Scoring Guideline

Score	In this item, . . .
4	The student demonstrates a thorough understanding of linear equations by correctly solving problems with clear and complete procedures and explanations when required.
3	The student demonstrates a general understanding of linear equations by solving problems and providing procedures and explanations with only minor errors or omissions.
2	The student demonstrates a partial understanding of linear equations by providing a portion of the correct problem solving, procedures, and explanations.
1	The student demonstrates a minimal understanding of linear equations.
0	The response has no correct answer and insufficient evidence to demonstrate any understanding of the mathematical concepts and procedures as required by the task. Response may show only information copied from the question.

Top-Scoring Student Response and Training Notes

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

Top-Scoring Response

Part A (2 points):

1/2 point for <u>each</u> correct equation

1/2 point for <u>each</u> correct answer

    OR 1/2 point for switching the answers

Note: Any pair of variables is acceptable as long as the variables are consistent.

What?
$4g + 3d = 51.50$ **OR equivalent** $2g + 4d = 45.50$ **OR equivalent**   **AND**   cost of a bag of granola: ($)6.95   cost of a bag of dried fruit: ($)7.90

Part B (1 point):

1 point for correct and complete explanation

    OR 1/2 point for correct but incomplete explanation

Why?
Sample Explanation: The point $(20, 0)$ signifies that Andrea started hiking 20 minutes after Carter.   **OR equivalent**

Part C (1 point):

1 point for correct and complete explanation

OR 1/2 point for correct but incomplete explanation

Why?

Sample Explanation:

After 40 minutes have passed since Carter started, he and Andrea are both 1.5 miles into the walk.

OR

The time at which Andrea and Carter are both the same distance from the park entrance (or picnic area).

OR equivalent

STUDENT RESPONSE

🖥 **Computer Response Score: 4 points**

PART A

Question 14
Page 1 of 2

| Line Guide | | | | | | X+Y | | Item ID | ? |

Andrea and Carter are going on a picnic.

To prepare for the picnic, Andrea buys 4 bags of granola and 3 bags of dried fruit and spends $51.50. Carter buys 2 bags of granola and 4 bags of dried fruit and spends $45.50.

A. Write and solve a system of equations to determine the cost of a bag of granola and the cost of a bag of dried fruit.

EQ

x= Cost of granola y=Cost of dry fruit
Andrea $4x + 3y = 51.50$
Carter $2x + 4y = 45.50$

76 / 1000

EQ

cost of a bag of granola: $ 6.95

4 / 50

EQ

cost of a bag of dried fruit: $ 7.90

4 / 50

Review/End Test | Pause | Flag | Options | Next

Part A: The student provided two correct equations for the system of equations (*4x + 3y = 51.50* and *2x + 4y = 45.50*). While not required for Part A, the student identified *x* as *Cost of [a bag of] granola* and *y* as *Cost of [a bag of] dry fruit*. The student also provided the correct answer for the cost of a bag of granola ($*6.95*) and the correct answer for the cost of a bag of dried fruit ($*7.90*). While support is not required for Part A, the student may have multiplied each term in Carter's equation by $^-2$, resulting in $^-4x + {}^-8y = {}^-91.00$, added that equation to Andrea's equation to cancel the *x* terms, resulting in $^-5y = {}^-39.50$, and divided both sides of that equation by $^-5$, resulting in *y* = 7.9, which is the cost of a bag of dried fruit; the student may have then substituted 7.9 for *y* in Andrea's equation, resulting in 4*x* + 3(7.9) = 51.50, solved for *x* by subtracting the product of 3(7.9) from each side of the equation, resulting in 4*x* = 27.8, and then divided both sides of that equation by 4, resulting in *x* = 6.95, which is the cost of a bag of granola. [2 points]

PARTS B and C

Line Guide | X+Y | Item ID | ?

Andrea and Carter are going on a picnic.

Andrea and Carter will both hike to the picnic area from the park entrance. Carter starts at the park entrance and begins hiking to the picnic area at a constant rate. Andrea starts at the park entrance some time later than Carter and begins hiking toward the picnic area at a different constant rate. The picnic area is 3 miles from the park entrance. The graph below represents this situation.

🔍 Enlarge

B. Explain why the graph of Andrea's line starts at (20, 0).

EQ

Andrea's line starts at (20,0) because she started hiking 20 minutes after Carter started hiking. the 20 represents how long carter hiked before she started, and the 0 represents how many miles she started at After Carter had hiked 20 minutes.

243 / 1000

C. Explain what the solution to the system of equations graphed in **part B** represents in the context of this problem.

EQ

The solution to the system of equations shows that after Carter had hiked for 40 minutes, they had both hiked 1.5 miles.

120 / 1000

Review/End Test | Pause | Flag 🚩 | Options | Back | Next

Part B: The student provided a correct and complete explanation as to why the graph of Andrea's line starts at $(20, 0)$ (*she started hiking 20 minutes after Carter started hiking*). [1 point]

Part C: The student provided a correct and complete explanation as to what $(40, 1.5)$, the solution to the system of equations graphed in Part B, represents in the context of this problem by correctly explaining what the 40 represents (*after Carter had hiked for 40 minutes*) and what the 1.5 represents (*they had both hiked 1.5 miles*). [1 point]

STUDENT RESPONSE

Response Score: 3 points

14. Andrea and Carter are going on a picnic.

To prepare for the picnic, Andrea buys 4 bags of granola and 3 bags of dried fruit and spends $51.50. Carter buys 2 bags of granola and 4 bags of dried fruit and spends $45.50.

A. Write and solve a system of equations to determine the cost of a bag of granola and the cost of a bag of dried fruit.

$$4x + 3y = 51.50$$
$$2x + 4y = 45.50$$

cost of a bag of granola: $ __7.9__

cost of a bag of dried fruit: $ __6.95__

Go to the next page to finish question 14.   **GO ON** ▶

Part A: The student provided two correct equations for the system of equations (*4x+3y=51.50* and *2x+4y=45.50*). The student also provided the correct answers for the costs of the granola and dried fruit ($*7.9* and $*6.95*) but switched the answers and recorded them on the incorrect lines. No support (work or explanation) is required for Part A, so it is unclear where an error was made. The student may have multiplied each term in the second equation by $^-2$, resulting in $^-4x + {}^-8y = {}^-91.00$, added that equation to the first equation to cancel out the *x* terms, resulting in $^-5y = {}^-39.50$, divided both sides of that equation by $^-5$, resulting in *y* = 7.9 but then recorded that answer on the first answer line (cost of a bag of granola) since it was the first solution found; the student may have then substituted 7.9 for *y* in the second equation, resulting in $2x + 4(7.9) = 45.50$, solved for *x* by subtracting the product of $4(7.9)$ from each side of the equation, resulting in 2*x* = 13.9, divided both sides of that equation by 2, resulting in *x* = 6.95, but then recorded that answer on the second answer line since it was the second solution found. [1.5 points]

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

Andrea and Carter will both hike to the picnic area from the park entrance. Carter starts at the park entrance and begins hiking to the picnic area at a constant rate. Andrea starts at the park entrance some time later than Carter and begins hiking toward the picnic area at a different constant rate. The picnic area is 3 miles from the park entrance. The graph below represents this situation.

Hiking to Picnic Area

B. Explain why the graph of Andrea's line starts at (20, 0).

Andrea started 20 minutes after Carter, therefore her line starts at the 20 minute mark.

C. Explain what the solution to the system of equations graphed in **part B** represents in the context of this problem.

Andrea will meet Carter at the point (40, 1.5) or 1.5 miles into their hike.

AFTER YOU HAVE FINISHED YOUR WORK, CLOSE THIS BOOKLET SO YOUR TEACHER WILL KNOW YOU ARE FINISHED.

STOP

Part B: The student provided a correct and complete explanation as to why the graph of Andrea's line starts at $(20, 0)$ (*Andrea started 20 minutes after Carter, therefore her line starts at the 20 minute mark*). [1 point]

Part C: The student provided a partially correct explanation describing what $(40, 1.5)$, the solution to the system of equations graphed in Part B, represents in the context of this problem. The student correctly explained what the 1.5 represents (*Andrea will meet Carter . . . 1.5 miles into their hike*) but did not explain what the 40 represents. [0.5 points]

STUDENT RESPONSE

🖥 **Computer Response Score: 2 points**

PART A

Question 14
Page 1 of 2

Line Guide | X+Y | Item ID | ?

Andrea and Carter are going on a picnic.

To prepare for the picnic, Andrea buys 4 bags of granola and 3 bags of dried fruit and spends $51.50. Carter buys 2 bags of granola and 4 bags of dried fruit and spends $45.50.

A. Write and solve a system of equations to determine the cost of a bag of granola and the cost of a bag of dried fruit.

EQ

$4x + 3y = 51.50$
$2x + 4y = 45.50$
$x = granola \quad y = fruit$

38 / 1000

EQ

cost of a bag of granola: $ 10.75

5 / 50

EQ

cost of a bag of dried fruit: $ 6

1 / 50

Review/End Test | Pause | Flag | Options | Next

Part A: The student provided two correct equations for the system of equations ($4x + 3y = 51.50$ and $2x + 4y = 45.50$). While not required for Part A, the student also identified x as representing the cost of a bag of granola and y as representing the cost of a bag of dried fruit. However, the student provided incorrect answers for both the cost of a bag of granola (10.75) and the cost of a bag of dried fruit (6). No support (work or explanation) is required for Part A, so it is unclear where an error was made. The student may have ignored the x values from both equations, found the difference between the remaining terms ($3y − 4y = 51.50 − 45.50$), which results in $^{-}y = 6.00$, and then recorded 6 in the answer space for the cost of a bag of dried fruit without considering the negative sign; the student may have then substituted 6 in for y in the second equation, resulting in $2x + 4(6) = 45.50$, solved for x by subtracting the product of $4(6)$ from each side of the equation, resulting in $2x = 21.5$, divided both sides of that equation by 2, resulting in $x = 10.75$, and recorded that answer in the answer space for the cost of a bag of granola. [1 point]

PARTS B and C

Line Guide

Item ID ?

Andrea and Carter are going on a picnic.

Andrea and Carter will both hike to the picnic area from the park entrance. Carter starts at the park entrance and begins hiking to the picnic area at a constant rate. Andrea starts at the park entrance some time later than Carter and begins hiking toward the picnic area at a different constant rate. The picnic area is 3 miles from the park entrance. The graph below represents this situation.

🔍 Enlarge

B. Explain why the graph of Andrea's line starts at (20, 0).

EQ

She was 20 minutes behind Carter before she started to hike.

60 / 1000

C. Explain what the solution to the system of equations graphed in **part B** represents in the context of this problem.

EQ

The solution (40,1.5) is where Carter and Andrea crossed paths.

63 / 1000

Review/End Test   Pause   Flag 🚩   Options   Back Next

Part B: The student provided a correct and complete explanation as to why the graph of Andrea's line starts at $(20, 0)$ (*She was 20 minutes behind Carter before she started to hike*). [1 point]

Part C: The student provided an incorrect explanation as to what $(40, 1.5)$, the solution to the system of equations graphed in Part B, represents in the context of this problem (*where Carter and Andrea crossed paths*). Identifying $(40, 1.5)$ as the intersection where Carter and Andrea met is an insufficient explanation to earn credit. The student needed to explain that 40 represents the time Carter hiked and 1.5 represents the distance Carter and Andrea had hiked. [0 points]
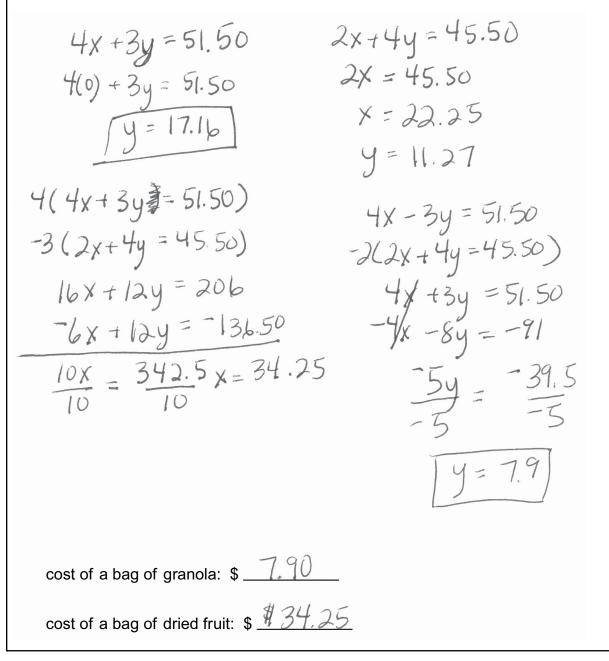
STUDENT RESPONSE

Response Score: 1 point

14. Andrea and Carter are going on a picnic.

To prepare for the picnic, Andrea buys 4 bags of granola and 3 bags of dried fruit and spends $51.50. Carter buys 2 bags of granola and 4 bags of dried fruit and spends $45.50.

A. Write and solve a system of equations to determine the cost of a bag of granola and the cost of a bag of dried fruit.

$$4x + 3y = 51.50$$
$$4(0) + 3y = 51.50$$
$$\boxed{y = 17.16}$$

$$4(4x + 3y = 51.50)$$
$$-3(2x + 4y = 45.50)$$
$$16x + 12y = 206$$
$$-6x + 12y = -136.50$$
$$\frac{10x}{10} = \frac{342.5}{10} \quad x = 34.25$$

$$2x + 4y = 45.50$$
$$2x = 45.50$$
$$x = 22.25$$
$$y = 11.27$$

$$4x - 3y = 51.50$$
$$-2(2x + 4y = 45.50)$$
$$4x + 3y = 51.50$$
$$-4x - 8y = -91$$
$$\frac{-5y}{-5} = \frac{-39.5}{-5}$$
$$\boxed{y = 7.9}$$

cost of a bag of granola: $ ___7.90___

cost of a bag of dried fruit: $ ___$34.25___

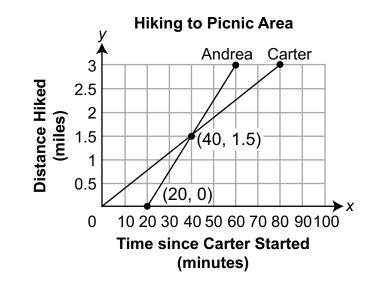**Go to the next page to finish question 14.**   **GO ON ▶**

Part A: The student provided two correct equations for the system of equations (*4x + 3y = 51.50* and *2x + 4y = 45.50*). However, the student provided incorrect answers for both the cost of a bag of granola ($*7.90*) and the cost of a bag of dried fruit ($*34.25*). The student provided work, although the work is not required or assessed. Based on the work provided, the student correctly calculated $y = 7.9$ by multiplying the second equation by $^-2$, resulting in $^-4x - 8y = {}^-91$, added that equation to the first equation to cancel the x terms, resulting in $^-5y = {}^-39.5$, divided both sides of the equation by $^-5$, resulting in $y = 7.9$, but then recorded that answer on the first answer line since it was the first solution found; the student then attempted to solve for x by multiplying the first equation by 4 and the second equation by $^-3$, resulting in $16x + 12y = 206$ and $^-6x + 12y = {}^-136.50$, but made an error when adding the two equations by adding 206 and 136.50 rather than adding 206 and $^-136.50$, resulting in 342.5 rather than 69.5, leading to an incorrect answer for x, which was then recorded on the second answer line since it was the second solution found. Only one correct solution was found and it was written in the wrong answer space, so the solution received no credit. [1 point]

14. **_Continued._** Please refer to the previous page for task explanation.

Andrea and Carter will both hike to the picnic area from the park entrance. Carter starts at the park entrance and begins hiking to the picnic area at a constant rate. Andrea starts at the park entrance some time later than Carter and begins hiking toward the picnic area at a different constant rate. The picnic area is 3 miles from the park entrance. The graph below represents this situation.

Hiking to Picnic Area

Time since Carter Started (minutes)

B. Explain why the graph of Andrea's line starts at (20, 0).

She didn't start at the Park entrance like Carter did

C. Explain what the solution to the system of equations graphed in **part B** represents in the context of this problem.

(40, 1.5) is where they passed each other

AFTER YOU HAVE FINISHED YOUR WORK, CLOSE THIS BOOKLET SO YOUR TEACHER WILL KNOW YOU ARE FINISHED.

STOP

Part B: The student provided an incorrect explanation as to why the graph of Andrea's line starts at $(20, 0)$ (*She didn't start at the Park entrance like Carter did*). The student may have misread the ordered pair as a location at the park rather than a relationship between the time since Carter started hiking and the distance Carter and Andrea hiked, interpreting the (0, 0) as the park entrance and $(20, 0)$ as a point some distance away from the park entrance. [0 points]

Part C: The student provided an incorrect explanation as to what $(40, 1.5)$, the solution to the system of equations graphed in Part B, represents in the context of this problem (*where they passed each other*). Identifying $(40, 1.5)$ as the intersection where Carter and Andrea met is an insufficient explanation to earn credit. The student needed to explain that 40 represents the time Carter hiked and 1.5 represents the distance Carter and Andrea had hiked. [0 points]

STUDENT RESPONSE

🖥 **Computer Response Score: 0 points**

PART A

Question 14 Page 1 of 2	[toolbar icons]

Andrea and Carter are going on a picnic.

To prepare for the picnic, Andrea buys 4 bags of granola and 3 bags of dried fruit and spends $51.50. Carter buys 2 bags of granola and 4 bags of dried fruit and spends $45.50.

A. Write and solve a system of equations to determine the cost of a bag of granola and the cost of a bag of dried fruit.

$4x + 3x = 51.50$ Andrea

Carter $2x + 4x = 45.50$

38 / 1000

cost of a bag of granola: $ 12.50   5 / 50

cost of a bag of dried fruit: $ .50   3 / 50

Review/End Test   Pause   Flag   Options   Next

Part A: The student provided two incorrect equations for the system of equations (*4x + 3x = 51.50* and *2x + 4x = 45.50*). In both equations, the variable *x* was incorrectly used to represent both the cost of a bag of granola and the cost of a bag of dried fruit. The student also provided incorrect answers for the cost of a bag of granola ($*12.50*) and for the cost of a bag of dried fruit ($*.50*). No support (work or explanation) is required for Part A, so it is unclear where an error was made. The student may have just selected a pair of numbers that worked for the first equation, finding $4(12.50) + 3(.50) = 51.50$ without noticing that $2(12.50) + 4(.50) \neq 45.50$.
[0 points]

PARTS B and C

Question 14
Page 2 of 2

Andrea and Carter are going on a picnic.

Andrea and Carter will both hike to the picnic area from the park entrance. Carter starts at the park entrance and begins hiking to the picnic area at a constant rate. Andrea starts at the park entrance some time later than Carter and begins hiking toward the picnic area at a different constant rate. The picnic area is 3 miles from the park entrance. The graph below represents this situation.

🔍 Enlarge

B. Explain why the graph of Andrea's line starts at (20, 0).

> Andrea was ahead by 20 minutes because she hiked a steadier constant rate then carter.

87 / 1000

C. Explain what the solution to the system of equations graphed in **part B** represents in the context of this problem.

> In the equations it shows how much the food cost for the picnic and in the graph it shows how long it takes andrea and carter to get from the park entrance to the picinic area and adrea took longer to start walking because she got to the park entrance after carter.

265 / 1000

Review/End Test   Pause   Flag 🚩   Options   Back   Next

Part B: The student provided an incorrect explanation as to why the graph of Andrea's line starts at $(20, 0)$ (*Andrea was ahead by 20 minutes*). The student may have misread the graph and interpreted the 20 as Andrea starting 20 minutes before Carter started rather than 20 minutes after Carter started. [0 points]

Part C: The student provided an incorrect explanation as to what $(40, 1.5)$, the solution to the system of equations graphed in Part B, represents in the context of this problem (*in the graph it shows how long it takes andrea and carter to get from the park entrance to the picnic area and adrea took longer to start walking because she got to the park entrance after carter*). The student needed to explain that 40 represents the time Carter hiked and 1.5 represents the distance Carter and Andrea had hiked. [0 points]

Algebra I Module 1—Summary Data

Multiple-Choice

An asterisk (*) indicates the key.

Sample Number	Alignment	Answer Key	Depth of Knowledge	*p*-value A	*p*-value B	*p*-value C	*p*-value D
1	A1.1.1.1.1	C	2	8%	26%	52%*	14%
2	A1.1.1.1.2	A	2	62%*	14%	19%	5%
3	A1.1.1.5.2	C	1	19%	12%	47%*	22%
4	A1.1.1.5.3	D	1	12%	12%	32%	44%*
5	A1.1.2.1.1	B	2	11%	42%*	31%	16%
6	A1.1.2.1.2	B	2	27%	59%*	9%	5%
7	A1.1.2.2.1	A	2	65%*	16%	11%	8%
8	A1.1.2.2.2	C	2	15%	6%	66%*	13%
9	A1.1.3.1.1	D	1	7%	16%	10%	67%*
10	A1.1.3.1.2	D	2	26%	16%	25%	33%*
11	A1.1.3.1.3	B	2	8%	62%*	7%	23%
12	A1.1.3.2.1	C	2	9%	17%	68%*	6%

Constructed-Response

Sample Number	Alignment	Points	Depth of Knowledge	Mean Score
13	A1.1.1	4	2	1.12
14	A1.1.2	4	3	1.69

Keystone Exams
Algebra I

Item and Scoring Sampler