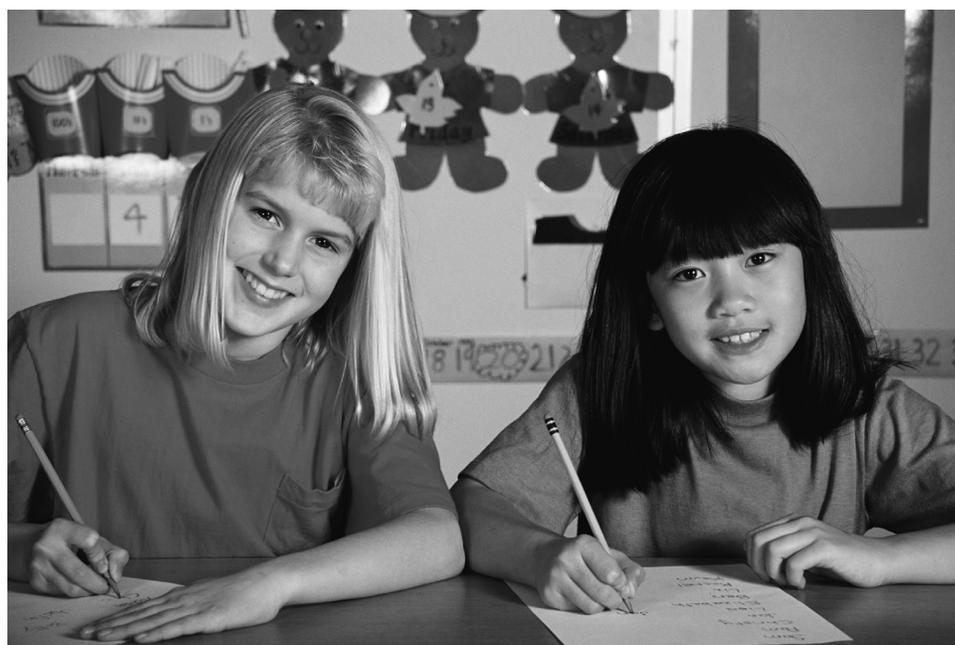




**pennsylvania**  
DEPARTMENT OF EDUCATION

# The Pennsylvania System of School Assessment

## Mathematics Item and Scoring Sampler



**2023–2024**  
**Grade 4**

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## INTRODUCTION

### General 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 Academic Standards, Assessment Anchors and Eligible Content (AAEC) documents, assessment handbooks, and content-based item and scoring samplers. This Item and Scoring Sampler is a useful tool for Pennsylvania educators in preparing local instructional programs by providing samples of test item types and scored student responses. The item sampler is not designed to be used as a pretest, a curriculum, or any other benchmark for operational testing.

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

### Pennsylvania Core Standards (PCS)

This sampler contains examples of test questions designed to assess the Pennsylvania Assessment Anchors and Eligible Content aligned to the PCS. The Mathematics, Reading, and Writing PSSA transitioned to PCS-based operational Mathematics and English Language Arts assessments starting with the spring 2015 PSSA administration.

The PCS-aligned Assessment Anchors and Eligible Content documents are posted on this portal:

- [www.education.pa.gov](http://www.education.pa.gov) [Hover over “Data and Reporting,” select “Assessment and Accountability,” and select “PSSA-PA System of School Assessment.” Then select “Assessment Anchors/Eligible Content” on the right side of the screen.]

### What Is Included

This sampler contains test questions, or test “items,” that have been written to align to the Assessment Anchors that are based on the PCS. The sample test questions model the types of items that may appear on an operational PSSA. Each sample test question has been through a rigorous review process to ensure alignment with the Assessment Anchors prior to being piloted in an embedded field test within a PSSA assessment and then used operationally on a PSSA assessment. Answer keys, scoring guidelines, and any related stimulus material are also included. Additionally, sample student responses are provided with each open-ended (OE) item to demonstrate the range of responses that students provided in response to these items.

## **Purpose and Uses**

The items in this sampler may be used<sup>1</sup> as examples for creating assessment items at the classroom level. Classroom teachers may find it beneficial to have students respond to the open-ended item in this sampler. Educators may then use the sampler as a guide to score the responses either independently or together with colleagues within a school or district. This sampler also includes the *General Description of Scoring Guidelines for Mathematics Open-Ended Items* that students will have access to during a PSSA mathematics administration. The general description of scoring guidelines may be distributed to students for use during local assessments and may also be used by educators when scoring local assessments.

## **Item Format and Scoring Guidelines**

The multiple-choice (MC) items have four answer choices. Each correct response to an MC item is worth one point.

Each OE item is designed to take approximately ten to fifteen minutes to complete. During the administration of the PSSA, students are given additional time as necessary to complete the test items. Each OE item in mathematics is scored using an item-specific scoring guideline based on a 0–4-point scale. In this sampler, every item-specific scoring guideline is combined with examples of student responses that represent each score point to form a practical, item-specific scoring guide.

## **Item Alignment**

All PSSA items are aligned to statements and specifications included in the *Assessment Anchors and Eligible Content Aligned to the Pennsylvania Core Standards*. The mathematics content, process skills, directives, and action statements included in the PSSA mathematics questions align with the Assessment Anchor Content Standards. The Eligible Content statements represent the limits of the content of the mathematics questions.

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<sup>1</sup> The permission to copy and/or use these materials does not extend to commercial purposes.

## Testing Time and Mode of Testing Delivery for the PSSA

The PSSA is delivered in a traditional paper-and-pencil format as well as in an online format. The estimated time to respond to a test question is the same for both methods of test delivery. The following table shows the estimated response time for each item type.

<b>Mathematics Item Type</b>	<b>MC</b>	<b>OE</b>
Estimated Response Time (minutes)	2	10 to 15

During an official test administration, students are given as much additional time as is necessary to complete the test questions.

## Mathematics Reporting Categories

The Assessment Anchors are organized into four classifications as listed below.

• A = Numbers and Operations	• C = Geometry
• B = Algebraic Concepts	• D = Data Analysis and Probability

These four classifications are used throughout the grade levels. In addition to these classifications, there are five Reporting Categories for each grade level. The first letter of each Reporting Category represents the classification; the second letter represents the Domain as stated in the Common Core State Standards for Mathematics. Listed below are the Reporting Categories for Grade 4.

- A-T = Numbers and Operations in Base Ten
- A-F = Numbers and Operations—Fractions
- B-O = Operations and Algebraic Thinking
- C-G = Geometry
- D-M = Measurement and Data

Examples of MC and OE items assessing these categories are included in this sampler.

## Item and Scoring Sampler Format

This sampler includes the test directions and scoring guidelines that appear in the PSSA Mathematics assessments. Each MC item is followed by a table that includes the item alignment, the answer key, the depth of knowledge (DOK) level, the percentage<sup>2</sup> of students who chose each answer option, and a brief answer-option analysis or rationale. The OE item is followed by a table that includes the item alignment, the DOK level, 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 Mathematics Open-Ended Items* 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 the item and scoring sampler accessible to as many people as possible.

### Example Multiple-Choice Item Information Table

Item 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

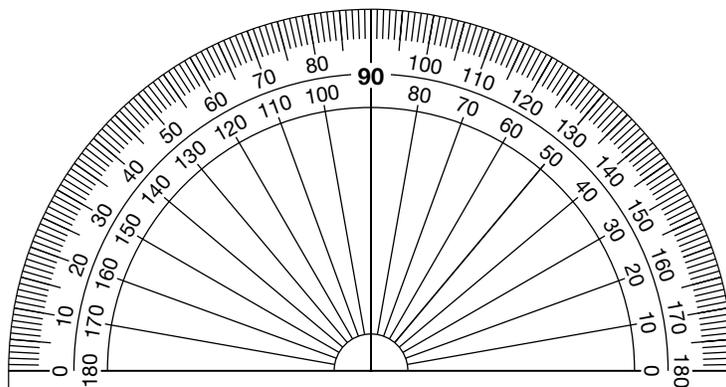
### Example Open-Ended Item Information Table

Alignment	Assigned AAEC	Depth of Knowledge	Assigned DOK	Mean Score	Average Score

<sup>2</sup> All p-value percentages listed in the item information tables have been rounded.

### Grade 4 Protractor

The protractor shown below is not intended to be used to measure. It has been included as a representation of the protractors that will be provided for students when they take the test. Due to differences in printers, the protractor in this sampler may not accurately reproduce to scale.



**General Description of Scoring Guidelines for Mathematics Open-Ended Items**

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

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

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

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

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

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

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

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

The response may show only information copied from the question.

Special Categories within zero reported separately:

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

OT.....Is off-task

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

IL.....Is illegible

Grade 4 Formula Sheet

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

2023  
 Grade 4

**Standard Conversions**

- 1 yard (yd) = 3 feet (ft)
- 1 foot = 12 inches (in.)
  
- 1 pound (lb) = 16 ounces (oz.)
  
- 1 gallon (gal) = 4 quarts (qt)
- 1 quart = 2 pints (pt)
- 1 pint = 2 cups (c)

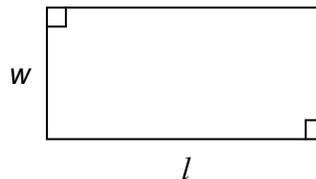
**Metric Conversions**

- 1 kilometer (km) = 1,000 meters (m)
- 1 meter = 100 centimeters (cm)
  
- 1 kilogram (kg) = 1,000 grams (g)
  
- 1 liter (L) = 1,000 milliliters (mL)

**Time Conversions**

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

**Rectangle**



Area = length  $\times$  width  
 $A = l \times w$

Perimeter = length + length + width + width  
 $P = l + l + w + w$

**MATHEMATICS TEST DIRECTIONS**

On the following pages are the mathematics questions.

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

**Directions for Multiple-Choice Questions**

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

For the multiple-choice questions:

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

**Directions for Open-Ended Questions**

Some questions will require you to write your response.

For the open-ended questions:

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

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

## MULTIPLE-CHOICE ITEMS

1. Divide:  $5,113 \div 3$

- A. 171
- B. 174 R1
- C. 1,701
- D. 1,704 R1

Item Information	
Alignment	A-T.2.1.3
Answer Key	D
Depth of Knowledge	1
p-value A	9%
p-value B	17%
p-value C	19%
p-value D	55% (correct answer)
Option Annotations	<p>A. omits the 1 in the tens place of the dividend since 3 cannot divide evenly into 1 and does not use a 0 as a placeholder in the tens place of the quotient</p> <p>B. does not use a 0 as a placeholder in the tens place of the quotient</p> <p>C. omits the 1 in the tens place of the dividend since 3 cannot divide evenly into 1</p> <p>D. Correct: recognizes that 3 divides into 5 (thousands) 1 time with 2 remaining, that 3 divides into 21 (hundreds) 7 times with 0 remaining, that 3 divides into 1 (tens) 0 times with 1 remaining, and that 3 divides into 13 (ones) 4 times with 1 remaining</p>

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

2. In 2010, the population of Pittsburgh was 305,704. Which expression shows the population of Pittsburgh in expanded form?
- A.  $300 + 5 + 700 + 4$
  - B.  $30,000 + 5,000 + 700 + 4$
  - C.  $300,000 + 5,000 + 70 + 4$
  - D.  $300,000 + 5,000 + 700 + 4$

Item Information	
Alignment	A-T.1.1.2
Answer Key	D
Depth of Knowledge	1
p-value A	7%
p-value B	10%
p-value C	8%
p-value D	75% (correct answer)
Option Annotations	<p>A. expands within periods rather than by place value</p> <p>B. splits 305 into two parts: 30 and 5</p> <p>C. splits 704 into two parts: 70 and 4</p> <p>D. Correct: recognizes that the 3 is in the hundred-thousands place and represents 300,000, the 5 is in the thousands place and represents 5,000, the 7 is in the hundreds place and represents 700, and the 4 is in the ones place, and then uses these values to write <math>300,000 + 5,000 + 700 + 4</math></p>

3. The weights, in pounds, of four elephants are listed below.

12,495    12,954    12,599    12,763

Which number sentence correctly compares the weights, in pounds, of two of the elephants?

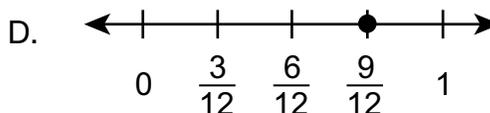
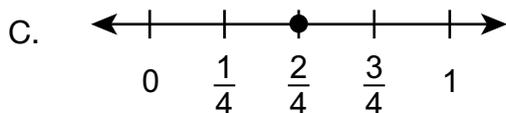
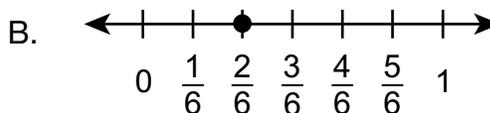
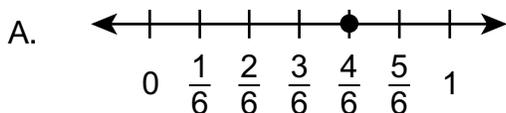
- A.  $12,495 > 12,954$
- B.  $12,599 > 12,954$
- C.  $12,495 = 12,954$
- D.  $12,763 < 12,954$

Item Information	
Alignment	A-T.1.1.3
Answer Key	D
Depth of Knowledge	1
p-value A	7%
p-value B	6%
p-value C	5%
p-value D	82% (correct answer)
Option Annotations	<p>A. looks only at the ones place</p> <p>B. sees the two 9s in 12,599 and thinks the number is automatically larger</p> <p>C. sees that both numbers have the same digits and thinks that the numbers must be equal</p> <p>D. Correct: compares the numbers in the ten-thousands place (<math>10,000 = 10,000</math>), then the numbers in the thousands place (<math>2,000 = 2,000</math>), and then the numbers in the hundreds place (<math>700 &lt; 900</math>)</p>

4. A total of 4,896 people went into a football stadium. The stadium had 8 gates. The same number of people went through each gate. Which sentence describes the **closest estimate** of the number of people who went through each gate?
- A. Since  $8 \times 6 = 48$ , a little less than 600 people went through each gate.
  - B. Since  $8 \times 6 = 48$ , a little more than 600 people went through each gate.
  - C. Since  $8 \times 6 = 48$ , a little less than 800 people went through each gate.
  - D. Since  $8 \times 6 = 48$ , a little more than 800 people went through each gate.

Item Information	
Alignment	A-T.2.1
Answer Key	B
Depth of Knowledge	2
p-value A	18%
p-value B	47% (correct answer)
p-value C	16%
p-value D	19%
Option Annotations	<p>A. does not recognize that the actual number of people should round down to 600 and not round up to 600</p> <p>B. Correct: recognizes that since <math>8 \times 6 = 48</math>, then <math>8 \times 600 = 4,800</math>, and since 4,800 is less than 4,896, the number of people would be a little more than 600</p> <p>C. confuses the meaning of the two multiplicands (interprets the meaning as <math>800 \times 6 = 4,800</math>) and does not recognize that the actual number of people should round down and not round up</p> <p>D. confuses the meaning of the two multiplicands (interprets the meaning as <math>800 \times 6 = 4,800</math>)</p>

5. Which number line shows a point that is graphed at a fraction that is equivalent to  $\frac{2}{3}$ ?



Item Information	
Alignment	A-F.1.1.1
Answer Key	A
Depth of Knowledge	1
p-value A	52% (correct answer)
p-value B	18%
p-value C	20%
p-value D	10%
Option Annotations	<p>A. Correct: recognizes that <math>\frac{2}{3} = \frac{4}{6}</math> and selects a graph with a point plotted at <math>\frac{4}{6}</math></p> <p>B. selects a point plotted at a fraction with the same numerator</p> <p>C. selects a point plotted on the second of three tick marks between 0 and 1</p> <p>D. either does not multiply the numerator and denominator of <math>\frac{2}{3}</math> by the same amount when finding an equivalent fraction OR finds a fraction equivalent to <math>\frac{3}{4} \left( \frac{9}{12} \right)</math> rather than one that is equivalent to <math>\frac{2}{3} \left( \frac{8}{12} \right)</math></p>

6. Angela practiced piano and guitar each day for 5 days.
- She practiced piano for  $\frac{3}{6}$  hour each day.
  - She practiced guitar for  $\frac{1}{6}$  hour each day.

What is the total amount of time, in hours, Angela practiced piano and guitar for the 5 days?

- A.  $\frac{20}{60}$
- B.  $\frac{20}{30}$
- C.  $\frac{20}{12}$
- D.  $\frac{20}{6}$

Item Information	
Alignment	A-F.2.1
Answer Key	D
Depth of Knowledge	2
p-value A	14%
p-value B	18%
p-value C	12%
p-value D	56% (correct answer)
Option Annotations	<p>A. adds numerators (<math>3 + 1</math>) and denominators (<math>6 + 6</math>) to get <math>\frac{4}{12}</math> and then multiplies both the numerator and the denominator of <math>\frac{4}{12}</math> by 5</p> <p>B. adds <math>\frac{3}{6}</math> to <math>\frac{1}{6}</math> and determines the sum is <math>\frac{4}{6}</math> but then multiplies both the numerator and the denominator of <math>\frac{4}{6}</math> by 5</p> <p>C. adds numerators (<math>3 + 1</math>) and denominators (<math>6 + 6</math>) to get <math>\frac{4}{12}</math> before multiplying <math>\frac{4}{12}</math> by 5</p> <p>D. Correct: adds <math>\frac{3}{6}</math> to <math>\frac{1}{6}</math> and determines the sum is <math>\frac{4}{6}</math>, since <math>3 + 1 = 4</math> and the common denominator does not change, and then multiplies <math>\frac{4}{6}</math> by 5 and determines the product is <math>\frac{20}{6}</math>, since <math>4 \times 5 = 20</math> and the denominator does not change when multiplying a fraction by a whole number</p>

7. Which expression represents  $1\frac{1}{3}$  written as a sum of unit fractions?

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

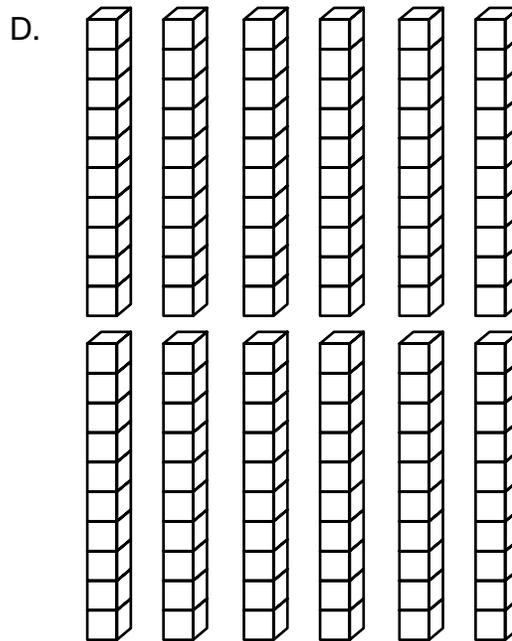
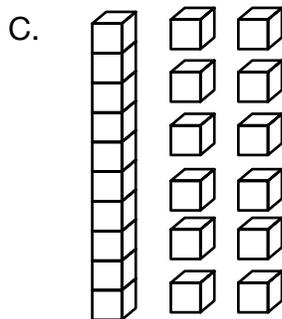
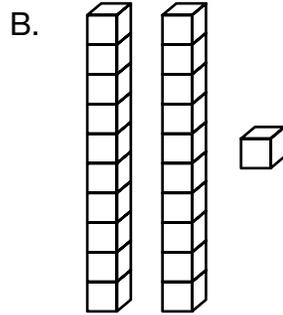
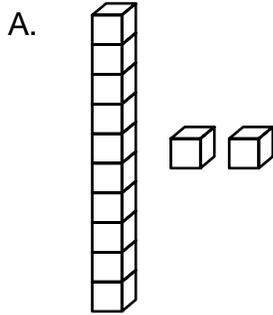
B.  $\frac{1}{3} + \frac{1}{3} + \frac{1}{3} + \frac{1}{3}$

C.  $\frac{1}{4} + \frac{1}{4} + \frac{1}{4}$

D.  $\frac{1}{6} + \frac{1}{6}$

Item Information	
Alignment	A-F.2.1.2
Answer Key	B
Depth of Knowledge	1
p-value A	11%
p-value B	78% (correct answer)
p-value C	6%
p-value D	5%
Option Annotations	<p>A. recognizes that the first <math>\frac{1}{1}</math> represents the 1 whole but then adds <math>\frac{1}{1} + \frac{1}{1} + \frac{1}{1}</math> and determines the sum is <math>\frac{1}{3}</math> by adding the denominators rather than the numerators</p> <p>B. Correct: either adds numerators to get <math>\frac{4}{3}</math>, which is equal to <math>1\frac{1}{3}</math>, OR recognizes that <math>\frac{1}{3} + \frac{1}{3} + \frac{1}{3} = \frac{3}{3} = 1</math> and that <math>1 + \frac{1}{3} = 1\frac{1}{3}</math></p> <p>C. confuses <math>\frac{4}{3}</math> with <math>\frac{3}{4}</math></p> <p>D. ignores the whole number 1</p>

8. Saul builds a model that represents the decimal 0.12. He uses a tens rod to represent one tenth and a ones cube to represent one hundredth. Which set of blocks could be the model Saul builds?



Item Information	
Alignment	A-F.3
Answer Key	A
Depth of Knowledge	2
p-value A	67% (correct answer)
p-value B	9%
p-value C	10%
p-value D	14%
Option Annotations	<p>A. Correct: either identifies that 1 tens rod = <math>\frac{1}{10}</math> (1 tenth) and 2 ones cubes = <math>\frac{2}{100}</math> (2 hundredths) and then adds <math>\frac{1}{10}</math> to <math>\frac{2}{100}</math> to get <math>\frac{12}{100}</math>, which is equal to 0.12, OR recognizes that a tens rod is the same as 10 ones cubes and identifies that 12 ones cubes = 0.12 (12 hundredths)</p> <p>B. switches the tenths and the hundredths</p> <p>C. either models the correct number of tenths but includes an additional 12 hundredths OR correctly models 12 hundredths but also includes an extra tenth</p> <p>D. models 12 tenths rather than 12 hundredths</p>

9. A farmer owns four times as many sheep as cows. She owns two more cows than horses. When the farmer places her sheep in 3 pens, each pen holds 8 sheep. How many horses does the farmer own?
- A. 4
  - B. 8
  - C. 94
  - D. 98

Item Information	
Alignment	B-O.1.1.3
Answer Key	A
Depth of Knowledge	2
p-value A	42% (correct answer)
p-value B	29%
p-value C	19%
p-value D	10%
Option Annotations	<p>A. Correct: multiplies 3 by 8 to get 24 sheep, divides 24 by 4 to get 6 cows, and subtracts 2 from 6 to get 4 horses</p> <p>B. adds 2 to the number of cows</p> <p>C. multiplies the number of sheep by 4 and subtracts 2 from the number of cows</p> <p>D. multiplies the number of sheep by 4 and adds 2 to the number of cows</p>

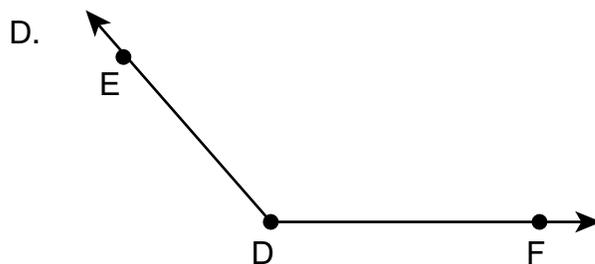
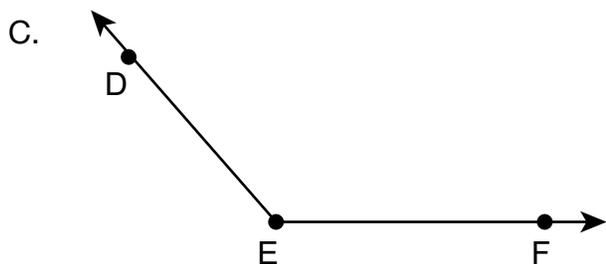
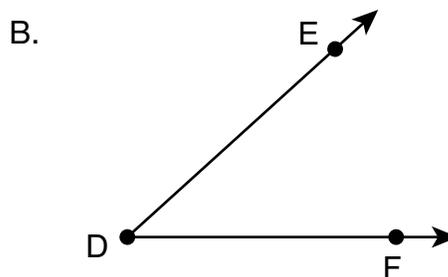
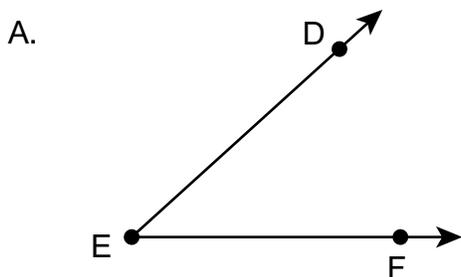
10. Mr. Larson has 57 tomato plants. He wants to put them in rows with the same number of tomato plants in each row. How many rows could Mr. Larson have using all 57 tomato plants?
- A. 3
  - B. 5
  - C. 7
  - D. 12

Item Information	
Alignment	B-O.2.1.1
Answer Key	A
Depth of Knowledge	2
p-value A	53% (correct answer)
p-value B	9%
p-value C	21%
p-value D	17%
Option Annotations	<ul style="list-style-type: none"> <li>A. Correct: recognizes that 3 and 19 is a factor pair of 57</li> <li>B. uses the digit in the tens place as a factor</li> <li>C. uses the digit in the ones place as a factor</li> <li>D. uses <math>5 + 7</math> as a factor</li> </ul>

11. Hannah makes a dog-walking area in the shape of a triangle. She uses 8 feet of fencing on each side of the dog-walking area. Which term describes each angle of Hannah’s dog-walking area?
- A. acute
  - B. obtuse
  - C. right
  - D. straight

Item Information	
Alignment	C-G.1.1
Answer Key	A
Depth of Knowledge	1
p-value A	60% (correct answer)
p-value B	15%
p-value C	15%
p-value D	10%
Option Annotations	<ul style="list-style-type: none"> <li>A. Correct: recognizes that a triangle with three equal side lengths is an equilateral triangle and that each angle of an equilateral triangle is an acute angle</li> <li>B. thinks an obtuse triangle can have three equal side lengths</li> <li>C. thinks a right triangle can have three equal side lengths</li> <li>D. does not realize that a straight angle cannot be part of a triangle</li> </ul>

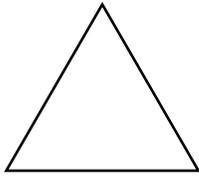
12. Which angle is obtuse and can be identified as angle DEF?



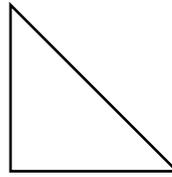
Item Information	
Alignment	C-G.1.1.1
Answer Key	C
Depth of Knowledge	1
p-value A	11%
p-value B	7%
p-value C	71% (correct answer)
p-value D	11%
Option Annotations	<p>A. selects an angle with a measure that is smaller than <math>90^\circ</math></p> <p>B. selects an angle with a measure that is smaller than <math>90^\circ</math> and has point D (the first letter of DEF) as its vertex</p> <p>C. Correct: selects an angle with a measure that is larger than <math>90^\circ</math> and has point E (the middle letter of DEF) as its vertex</p> <p>D. selects an angle with a measure that is larger than <math>90^\circ</math> but has point D (the first letter of DEF) as its vertex</p>

13. Which triangle **most likely** has both a right angle and a line of symmetry?

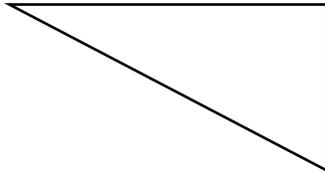
A.



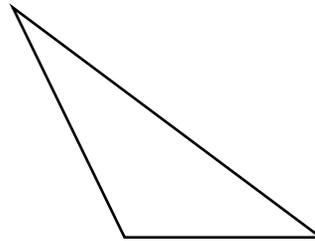
B.



C.



D.



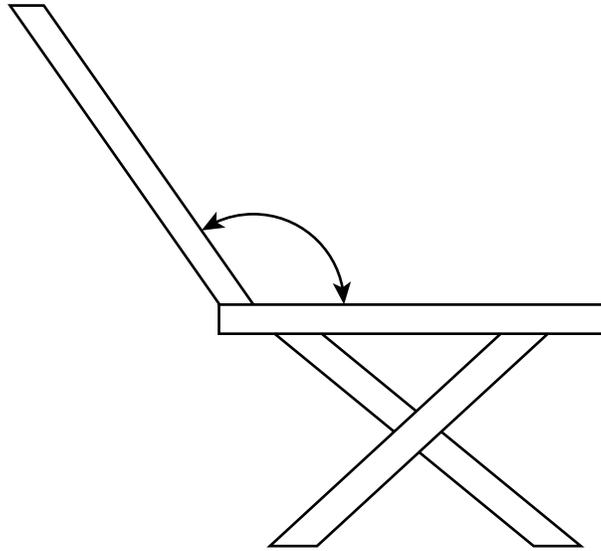
Item Information	
Alignment	C-G.1.1.3 C-G.1.1.2
Answer Key	B
Depth of Knowledge	2
p-value A	22%
p-value B	58% (correct answer)
p-value C	12%
p-value D	8%
Option Annotations	<p>A. recognizes that a triangle with 2 equal sides (or 2 equal angles) has a line of symmetry but does not recognize that all the angles are acute (no right angle)</p> <p>B. Correct: identifies the lower-left angle as a right angle and that a triangle with 2 equal sides (or 2 equal angles) has a line of symmetry</p> <p>C. identifies the upper-right angle as a right angle but does not recognize that a triangle with no equal sides (or no equal angles) does not have a line of symmetry</p> <p>D. does not recognize that the largest angle is obtuse (no right angle) or that a triangle with no equal sides (or no equal angles) does not have a line of symmetry</p>

14. The length of a fence is 12 **yards**. What is the length, in **feet**, of the fence?

- A. 4 feet
- B. 36 feet
- C. 120 feet
- D. 144 feet

Item Information	
Alignment	D-M.1.1.1
Answer Key	B
Depth of Knowledge	1
p-value A	15%
p-value B	66% (correct answer)
p-value C	11%
p-value D	8%
Option Annotations	<p>A. divides 12 by 3 rather than multiplying 12 by 3</p> <p>B. Correct: multiplies <math>12 \times 3</math> since there are 3 feet in each yard</p> <p>C. multiplies 12 by 10 (i.e., uses a metric conversion factor)</p> <p>D. multiplies 12 by 12 (i.e., converts using 1 foot = 12 inches rather than 1 yard = 3 feet)</p>

15. The seat and the back of a chair form an angle as shown below.

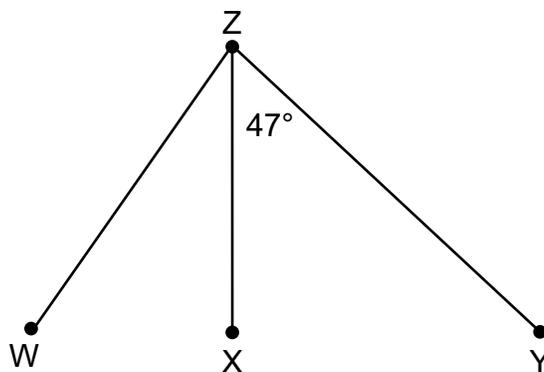


Using your protractor, what is the measure of the angle formed by the seat and the back of the chair?

- A.  $55^\circ$
- B.  $65^\circ$
- C.  $125^\circ$
- D.  $135^\circ$

Item Information	
Alignment	D-M.3.1.1
Answer Key	C
Depth of Knowledge	1
p-value A	20%
p-value B	15%
p-value C	46% (correct answer)
p-value D	19%
Option Annotations	<p>A. uses the outer scale on the protractor (but sees that the back of the chair passes halfway between <math>50^\circ</math> and <math>60^\circ</math>)</p> <p>B. uses the outer scale on the protractor, starts at <math>60^\circ</math> (rather than <math>50^\circ</math>), and then counts “up” 5 tick marks</p> <p>C. Correct: uses the inner scale on the protractor and sees that the back of the chair passes halfway between <math>120^\circ</math> and <math>130^\circ</math></p> <p>D. uses the inner scale on the protractor but counts up from <math>130^\circ</math> rather than from <math>120^\circ</math></p>

16. In the picture shown below, the measure of angle WZY is  $82^\circ$ .



What is the measure, in degrees, of angle WZX?

- A.  $35^\circ$
- B.  $43^\circ$
- C.  $129^\circ$
- D.  $164^\circ$

Item Information	
Alignment	D-M.3.1.2
Answer Key	A
Depth of Knowledge	2
p-value A	50% (correct answer)
p-value B	21%
p-value C	20%
p-value D	9%
Option Annotations	<p>A. Correct: subtracts <math>47^\circ</math> from <math>82^\circ</math> and determines the difference is <math>35^\circ</math></p> <p>B. subtracts <math>47^\circ</math> from <math>90^\circ</math>, without considering that angle WZY is <math>82^\circ</math> and not <math>90^\circ</math></p> <p>C. adds the two given angle measures (<math>82^\circ + 47^\circ</math>)</p> <p>D. subtracts <math>47^\circ</math> from <math>82^\circ</math> and determines the difference is <math>35^\circ</math> but then adds all three angle measures together (<math>82^\circ + 47^\circ + 35^\circ</math>)</p>

## OPEN-ENDED QUESTION

17. Three number patterns are described below.

- pattern A: Start at 10 and add 4.
- pattern B: Start at 30 and subtract 3.
- pattern C: Start at 6 and add 5.

A. What are the first four terms of pattern A?

\_\_\_\_\_ , \_\_\_\_\_ , \_\_\_\_\_ , \_\_\_\_\_

B. What numbers are in both pattern B and pattern C? Show or explain all your work.

Go to the next page to finish question 17.



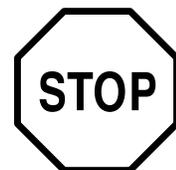
17. **Continued.** Please refer to the previous page for task explanation.

Another number pattern is shown below.

16, 14, 15, 13, 14, 12, 13, \_\_\_\_

- C. Explain how to determine whether the next number in the pattern is even or odd.

**After you have finished your work, close this booklet so your teacher will know you are finished.**



## Item-Specific Scoring Guideline

### #17 Item Information

<b>Alignment</b>	B-O.3	<b>Depth of Knowledge</b>	2	<b>Mean Score</b>	1.38
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### Assessment Anchor this item will be reported under:

M04.B-O.3—Generate and analyze patterns.

### Specific Anchor Descriptor addressed by this item:

M04.B-O.3.1—Recognize, describe, extend, create, and replicate a variety of patterns.

### Scoring Guide

<b>Score</b>	<b>In this item, the student . . .</b>
<b>4</b>	Demonstrates a thorough understanding of how to generate and analyze patterns by correctly solving problems and clearly explaining procedures.
<b>3</b>	Demonstrates a general understanding of how to generate and analyze patterns by correctly solving problems and clearly explaining procedures with only minor errors or omissions.
<b>2</b>	Demonstrates a partial understanding of how to generate and analyze patterns by correctly performing a significant portion of the required task.
<b>1</b>	Demonstrates minimal understanding of how to generate and analyze patterns.
<b>0</b>	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 how to generate and analyze patterns.
0	Response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.

**Top-Scoring Response**

**Part A (1 point):**

1 point for correct answer

What?	Why?
10, 14, 18, 22	

**Part B (2 points):**

$\frac{1}{2}$  point for each correct answer

OR 0 points for any incorrect answers

1 point for correct and complete explanation

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

What?	Why?
6 and 21	<p><b>Sample Work:</b>                      pattern B: 30, 27, 24, <u>21</u>, 18, 15, 12, 9, <u>6</u>, 3, 0                      pattern C: <u>6</u>, 11, 16, <u>21</u>, 26, 31, ...</p> <p><b>OR</b></p> <p><b>Sample Explanation:</b>                      Pattern B represents all the multiples of 3 up to 30, so I wrote out pattern C and circled the numbers that are multiples of 3 up to 30.</p> <p><b>OR equivalent</b></p>

**Part C (1 point):**

1 point for correct and complete explanation

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

What?	Why?
	<p><b>Sample Explanations:</b> The rule for the pattern is subtract 2, then add 1. The last number is 13. This comes from <math>12 + 1 = 13</math>. So, the next number is <math>13 - 2 = 11</math>, which is an odd number.</p> <p><b>OR</b></p> <p>The pattern is two even numbers followed by two odd numbers. Since the pattern shown ends with one odd number, the next number is also odd.</p> <p><b>OR equivalent</b></p>

## STUDENT RESPONSE

Response Score: 4 points



## PARTS A and B

Question 17  
Page 1 of 2

Three number patterns are described below.

- pattern A: Start at 10 and add 4.
- pattern B: Start at 30 and subtract 3.
- pattern C: Start at 6 and add 5.

A. What are the first four terms of pattern A?

EQ EQ EQ EQ

10 , 14 , 18 , 22

B. What numbers are in both pattern B and pattern C? Show or explain all your work.

EQ

B 30, 27, 24, 21, 18, 15, 12, 9, 6, 3  
C 6, 11, 16, 21, 26, 31, 36, 41

6 and 21 are in both pattern B and pattern C.

116 / 1000

Review/End Test Pause Flag Options Next

Part A. The student provided the correct terms for pattern A by starting at 10 and adding 4 each time (10, 14, 18, 22). [1 point]

Part B. The student provided the correct answer (6 and 21 are in both pattern B and pattern C) with correct and complete support. The student wrote out both patterns correctly: pattern B started at 30 and subtracted 3 each time, while pattern C started at 6 and added 5 each time. The student continued each pattern until pattern B reached a term less than any term in pattern C and pattern C reached multiple terms that were greater than any term in pattern B. The numbers 6 and 21 appeared in both patterns. [2 points]

## PART C

Question 17

Page 2 of 2



Item ID



Three number patterns are described below.

- pattern A: Start at 10 and add 4.
- pattern B: Start at 30 and subtract 3.
- pattern C: Start at 6 and add 5.

Another number pattern is shown below.

16, 14, 15, 13, 14, 12, 13, \_\_\_\_

C. Explain how to determine whether the next number in the pattern is even or odd.

first of all, the rule is -2, +1 so if you follow the rule you get to 12 then you +1 to get 13 and then the next step in the pattern is -2 so if  $13-2=11$  and 11 is an odd number. To find if a number is odd look in the ones place if you can divide it into two equal parts it is even and if you have two different parts the number is odd.

335 / 1000

Review/End Test

Pause

Flag

Options

Back

Next

Part C. The student provided a correct and complete explanation of how to determine whether the next number in the pattern is even or odd. First, the student correctly identified the pattern as  $-2, +1$ . Then, the student correctly explained how to use the pattern to find the next number and identified the next number as odd (*if you follow the rule you get to 12 then you +1 to get 13 and then the next step in the pattern is  $-2$  so if  $13 - 2 = 11$  and 11 is an odd number*). [1 point]

## STUDENT RESPONSE

## Response Score: 3 points

17. Three number patterns are described below.

- pattern A: Start at 10 and add 4.
- pattern B: Start at 30 and subtract 3.
- pattern C: Start at 6 and add 5.

A. What are the first four terms of pattern A?

10 , 14 , 18 , 22

Part A. The student provided the correct terms for pattern A by starting at 10 and adding 4 each time (10, 14, 18, 22). [1 point]

B. What numbers are in both pattern B and pattern C? Show or explain all your work.

30 27 24 (21)

6 11 16 (21) 26 31

(21 is in both)

Part B. The student provided one of the two correct answers (*21 is in both*) with correct but incomplete support. The student started both patterns correctly: pattern B started at 30 and subtracted 3 each time, while pattern C started at 6 and added 5 each time. The student continued pattern B until a term that was also in pattern C was found (21). The student continued pattern C until a term that was greater than any term in pattern B was found (31). To earn full credit, the student needed to continue pattern B until a term that was less than or equal to the smallest term in pattern C was found. Extending pattern B further, the student would have seen a second number that is in both patterns (6). [1 point]

Go to the next page to finish question 17.



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

Another number pattern is shown below.

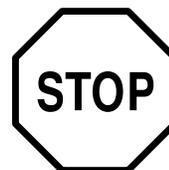
16, 14, 15, 13, 14, 12, 13, —

- C. Explain how to determine whether the next number in the pattern is even or odd.

First see the rule it goes even, even, odd, odd. So 14, 12 is even, 13 is odd, the next will be odd

Part C. The student provided a correct and complete explanation of how to determine whether the next number in the pattern is even or odd. First, the student correctly identified the pattern as *even, even, odd, odd*. Then, the student correctly explained how to use the pattern to find whether the next number is even or odd and identified the next number as odd (*So 14, 12 is even, 13 is odd, the next will be odd*). [1 point]

**After you have finished your work, close this booklet so your teacher will know you are finished.**



## STUDENT RESPONSE

Response Score: 2 points



## PARTS A and B

Question 17  
Page 1 of 2

Three number patterns are described below.

- pattern A: Start at 10 and add 4.
- pattern B: Start at 30 and subtract 3.
- pattern C: Start at 6 and add 5.

A. What are the first four terms of pattern A?

10 , 14 , 18 , 22

B. What numbers are in both pattern B and pattern C? Show or explain all your work.

The number that B and C have that is the same is 21.

30, 27, 24, 21  
6, 11, 16, 21

82 / 1000

Review/End Test Pause Flag Options Next

Part A. The student provided the correct terms for pattern A by starting at 10 and adding 4 each time (10, 14, 18, 22). [1 point]

Part B. The student provided one of the two correct answers (*The number that B and C have that is the same is 21.*) with correct but incomplete support. The student started both patterns correctly: pattern B started at 30 and subtracted 3 each time, while pattern C started at 6 and added 5 each time. The student continued each pattern until a term that was also in the other pattern was found (21). To earn full credit, the student needed to continue pattern B until a term that was less than or equal to the smallest term in pattern C was found and continue pattern C until a term that was greater than or equal to the largest term in pattern B was found. If both patterns had been extended further, the student would have seen a second number that is in both patterns (6). [1 point]

## PART C

Question 17  
Page 2 of 2



Item ID



Three number patterns are described below.

- pattern A: Start at 10 and add 4.
- pattern B: Start at 30 and subtract 3.
- pattern C: Start at 6 and add 5.

Another number pattern is shown below.

16, 14, 15, 13, 14, 12, 13, \_\_\_\_

C. Explain how to determine whether the next number in the pattern is even or odd.

The way to figer out if the next number is even or odd is to first find out wich number is next. Then if the number is 1, 3, 5, 7, or 9 its odd and if it's 2, 4, 6, 8, or 10 it's even.

184 / 1000

Review/End Test

Pause

Flag

Options

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Next

Part C. The student provided an incorrect explanation. Rather than explaining how to determine whether the next number in the pattern is even or odd, the student attempted to give a definition of whether a number is even or odd (*if the number is 1, 3, 5, 7, or 9 its odd and if it's 2, 4, 6, 8, or 10 it's even*); however, the student's definition only works for numbers less than or equal to 10. [0 points]

## STUDENT RESPONSE

## Response Score: 1 point

17. Three number patterns are described below.

- pattern A: Start at 10 and add 4.
- pattern B: Start at 30 and subtract 3.
- pattern C: Start at 6 and add 5.

A. What are the first four terms of pattern A?

14 , 18 , 22 , 26

Part A. The student provided an incorrect pattern (14, 18, 22, 26) by starting at 14 rather than starting at 10. The student did correctly add 4 each time, resulting in terms 2 through 5 of pattern A rather than terms 1 through 4. [0 points]

B. What numbers are in both pattern B and pattern C? Show or explain all your work.

Pattern B: 27, 24, 21, 18

Pattern C: 11, 16, 21, 26

Part B. The student provided no correct answers and incorrect support (work or explanation). For pattern B, the student began the pattern with the second term (27) rather than the first term (30) and then subtracted 3 each time. For pattern C, the student began the pattern with the second term (11) rather than the first term (6) and then added 5 each time. Although the student continued both patterns to one term past a common number in each pattern (21), the student did not identify that this number is in both patterns. [0 points]

Go to the next page to finish question 17.



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

Another number pattern is shown below.

16, 14, 15, 13, 14, 12, 13, \_\_\_\_

- C. Explain how to determine whether the next number in the pattern is even or odd.

The next number is odd because the pattern is  $-2 + 1$ .  $14 - 2 = 12 + 1 = 13$ . 13 starts the pattern again.  $13 - 2 = 11$  is an odd number.

Part C. The student provided a correct and complete explanation of how to determine whether the next number in the pattern is even or odd. First, the student correctly identified the pattern as  $-2 + 1$ . Then, the student explained how to use the pattern to find the next number ( $14 - 2 = 12 + 1 = 13$ . *13 starts the pattern again.*  $13 - 2 = 11$ ) and identified the next number as odd (*11 is an odd number*). The student's explanation contains a run-on equation, which is mathematically incorrect and would not allow a student to earn all 4 points for the item; however, this was ignored since this part of the explanation was extraneous. [1 point]

**After you have finished your work, close this booklet so your teacher will know you are finished.**



## STUDENT RESPONSE

Response Score: 0 points



## PARTS A and B

Question 17  
Page 1 of 2

Three number patterns are described below.

- pattern A: Start at 10 and add 4.
- pattern B: Start at 30 and subtract 3.
- pattern C: Start at 6 and add 5.

A. What are the first four terms of pattern A?

EQ

EQ	14	,	EQ	33	,	EQ	11	,	EQ	?
----	----	---	----	----	---	----	----	---	----	---

B. What numbers are in both pattern B and pattern C? Show or explain all your work.

EQ

I just added all the unmbers.

29 / 1000

Review/End Test   Pause   Flag   Options   Next

Part A. The student provided an incorrect pattern (14, 33, 11, ?). No support (work or explanation) is required, so it is unclear where an error was made. The student may have added the numbers together from the prompt for the first three numbers ( $10 + 4 = 14$ , pattern B:  $30 + 3 = 33$ , pattern C:  $6 + 5 = 11$ ). [0 points]

Part B. The student provided an incorrect explanation that may refer to the numbers provided in Part A (*I just added all the unmbers* [numbers]). The student did not identify which numbers are in both pattern B and pattern C, and the student did not provide any support (work or explanation) showing either pattern B or pattern C. [0 points]

## PART C

Question 17  
Page 2 of 2

Item ID



Three number patterns are described below.

- pattern A: Start at 10 and add 4.
- pattern B: Start at 30 and subtract 3.
- pattern C: Start at 6 and add 5.

Another number pattern is shown below.

16, 14, 15, 13, 14, 12, 13, \_\_\_\_

C. Explain how to determine whether the next number in the pattern is even or odd.

The pattrn is to subcratc 2 so the answer would be 11

54 / 1000

Review/End Test

Pause

Flag

Options

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Next

Part C. The student provided an incorrect explanation (*The pattrn is to subcratc [subtract] 2 so the answer would be 11*) of how to determine whether the next number in the pattern is even or odd. The student only identified the first part of the pattern (*subcratc [subtract] 2*) and did not explain whether 11 is even or odd. Identifying the next number as 11 does not earn any credit. [0 points]

**MATHEMATICS—SUMMARY DATA**

**Multiple-Choice**

Sample Number	Alignment	Answer Key	Depth of Knowledge	p-value A	p-value B	p-value C	p-value D
1	A-T.2.1.3	D	1	9%	17%	19%	55%
2	A-T.1.1.2	D	1	7%	10%	8%	75%
3	A-T.1.1.3	D	1	7%	6%	5%	82%
4	A-T.2.1	B	2	18%	47%	16%	19%
5	A-F.1.1.1	A	1	52%	18%	20%	10%
6	A-F.2.1	D	2	14%	18%	12%	56%
7	A-F.2.1.2	B	1	11%	78%	6%	5%
8	A-F.3	A	2	67%	9%	10%	14%
9	B-O.1.1.3	A	2	42%	29%	19%	10%
10	B-O.2.1.1	A	2	53%	9%	21%	17%
11	C-G.1.1	A	1	60%	15%	15%	10%
12	C-G.1.1.1	C	1	11%	7%	71%	11%
13	C-G.1.1.3 C-G.1.1.2	B	2	22%	58%	12%	8%
14	D-M.1.1.1	B	1	15%	66%	11%	8%
15	D-M.3.1.1	C	1	20%	15%	46%	19%
16	D-M.3.1.2	A	2	50%	21%	20%	9%

**Open-Ended**

Sample Number	Alignment	Points	Depth of Knowledge	Mean Score
17	B-O.3	4	2	1.38



## **PSSA Grade 4 Mathematics Item and Scoring Sampler**

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