



Arkansas Comprehensive Testing, Assessment, and Accountability Program

# TEACHER HANDBOOK

## GEOMETRY

## END-OF-COURSE EXAMINATIONS

## 2013–2014 ADMINISTRATIONS

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**Arkansas Department of Education**



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The **Arkansas Comprehensive Testing, Assessment, and Accountability Program (ACTAAP)** includes *Mid-Year* and *Spring Geometry End-of-Course Examinations* for students completing Geometry or the equivalent for high school graduation credit. The examinations consist of multiple-choice and open-response questions that directly assess student knowledge. The development of the Geometry End-of-Course Examinations was based on the *Arkansas Geometry Mathematics Curriculum Framework*.

In January or April 2014, all students who had completed or were completing the required course work for Geometry for high school graduation credit participated in the *Mid-Year* or *Spring Geometry End-of-Course Examination*. Results of the Geometry End-of-Course Examinations will be provided to all students, schools, and districts to be used as the basis for instructional change.

This handbook provides information regarding the scoring of student responses to the Geometry open-response items. It describes the scoring procedures and the scoring criteria (rubrics) used to assess student responses. Copies of actual student responses are provided, along with scores given to those responses, to illustrate how the scoring criteria were applied to Geometry open-response items.

Additional information about the Geometry End-of-Course Examination is available through the Arkansas Department of Education. Questions can be addressed to the Office of Student Assessment at 501-682-4558.

## SCORING STUDENT RESPONSES TO OPEN-RESPONSE ITEMS

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The multiple-choice and open-response test items for the Geometry End-of-Course Examination are developed with the assistance and approval of the Geometry Content Advisory Committee. This committee comprises active Arkansas educators with expertise in Mathematics education. The Geometry Content Advisory Committee develops and reviews multiple-choice and open-response items to ensure that they reflect the *Arkansas Geometry Mathematics Curriculum Framework*.

While multiple-choice items are scored by machine to determine if the student chose the correct answer from four options, responses to open-response items must be scored by trained “readers” using a pre-established set of scoring criteria.

### READER TRAINING

Readers are trained to score only one content area. Qualified readers for the Arkansas scoring will be those with a four-year college degree in mathematics, education, or related fields.

Before readers are allowed to begin assigning scores to any student responses, they go through intensive training. The first step in that training is for the readers to read the Geometry open-response items as they appear in the test booklet and to respond—just as the student test takers are required to do. This step gives the readers some insight into how the students might have responded. The next step is the readers’ introduction to the scoring rubric. All of the specific requirements of the rubric are explained by the Scoring Director who has been specifically trained to lead the scoring group. Then responses (anchor papers) that illustrate the score points of the rubric are presented to the readers and discussed. The goal of this discussion is for the readers to understand why a particular response (or type of response) receives a particular score. After discussion of the rubric and anchor papers, readers practice scoring sets of responses that have been prescored and selected for use as training papers. Detailed discussion of the responses and the scores they receive follows.

After three or four of these practice sets, readers are given “qualifying rounds.” These are additional sets of prescored papers, and, in order to qualify, each reader scoring Geometry responses must score in exact agreement on at least 80% of the responses. Readers who do not score within the required rate of agreement are not allowed to score the Geometry End-of-Course Examination responses.

Once scoring of the actual student responses begins, readers are monitored constantly throughout the project to ensure that they are scoring according to the criteria. Daily and cumulative statistics are posted and analyzed, and Scoring Directors or Team Leaders reread selected responses scored by the readers. These procedures promote reliable and consistent scoring. Any reader who does not maintain an acceptable level of agreement is dismissed from the project.

### SCORING PROCEDURES

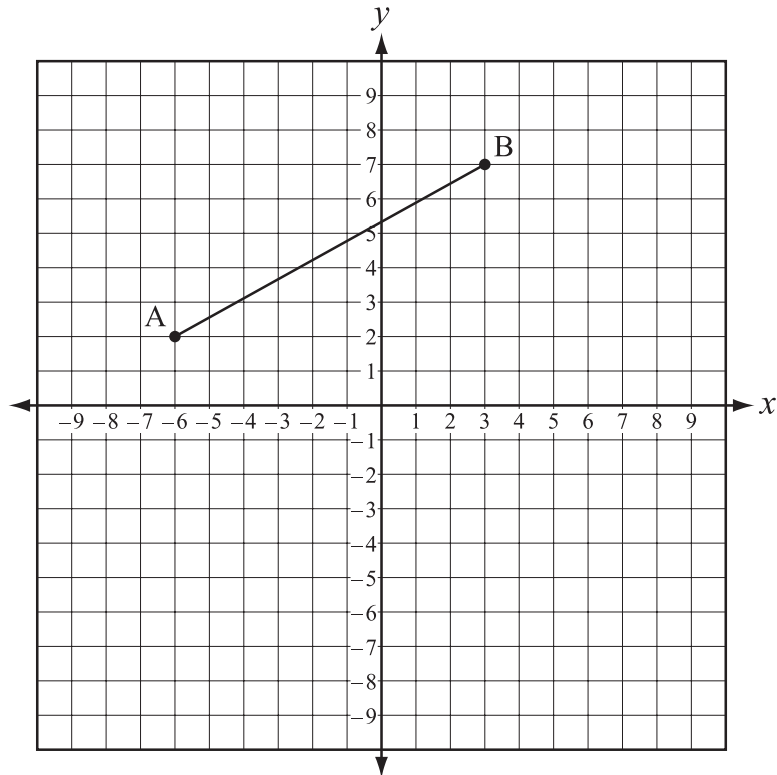
All student responses to the Geometry End-of-Course Examination open-response test items are scored independently by two readers. Those two scores are compared, and responses that receive scores that are non-adjacent (a “1” and a “3,” for example) are scored a third time by a Team Leader or the Scoring Director for resolution.

On the following pages, open-response items are presented as they appeared in the *2014 Mid-Year* and *Spring Geometry End-of-Course Examinations*. The specific scoring rubric for each item and annotated responses for each score point of the rubric follows. The goal is for classroom teachers and their students to understand how responses are scored. It is hoped that this understanding will help students see what kind of performance is expected of them on the Geometry End-of-Course Examination.

# **GEOMETRY RESPONSES**

# ITEM A—2014 GEOMETRY

- A. A city planning committee is looking at the number of streets that intersect a portion of a road within the city. In the coordinate grid below, line segment  $\overline{AB}$  below represents a road between two locations.



- Point A is at  $(-6, 2)$
  - Point B is at  $(3, 7)$
1. Each unit on the coordinate grid represents 10 miles. What is the unit length in miles of the road represented by  $\overline{AB}$ ? Round your answer to the nearest mile. Show your work.
  2. An existing road is perpendicular to the road represented by  $\overline{AB}$ . If this road were represented by line segment  $\overline{CD}$  on the coordinate grid, what would be the slope of  $\overline{CD}$ ? Show your work.
  3. Using the slope obtained in Part 2, find the equation of the line containing  $\overline{CD}$  if  $\overline{CD}$  contains the point  $(5, -2)$ . Show your work.

BE SURE TO LABEL YOUR RESPONSES 1, 2, AND 3.



Item A Scoring Rubric—2014 Geometry

Score	Description
4	The student earns 4 points. The response contains no incorrect work.
3	The student earns 3 – 3½ points.
2	The student earns 2 – 2½ points.
1	The student earns ½ – 1½ points, or some minimal understanding is shown.
0	The student earns 0 points. No understanding is shown.
B	Blank — No Response. A score of “B” will be reported as “NA.” (No attempt to answer the item. Score of “0” is assigned for the item.)

SOLUTION AND SCORING

Do not deduct for early rounding or truncating in internal work that results in the correct answer. Students may write these values for brevity, using the exact calculator value to find their answer.

4 points possible:

Part	Points
1	<p><b>1 point possible:</b></p> <p>1 point: Correct length: <b>103</b> (<i>miles not required</i>)                      Correct procedure is shown and/or explained                      Give credit for the following or equivalent:</p> <p>Ex. <math>d = 10 \cdot \sqrt{(3 - (-6))^2 + (7 - 2)^2} = 10 \cdot \sqrt{9^2 + 5^2} = 10 \cdot \sqrt{81 + 25} = 10 \cdot \sqrt{106}</math>  <math>= 10 \cdot 10.29563 \dots = 102.95630 \dots \approx 103</math></p> <p>Ex. “From Point A (-6,2), I counted right 9 and up 5 to Point B (3,7).                      Using the Pythagorean Theorem:  <math>d = 10 \cdot \sqrt{9^2 + 5^2} = 10 \cdot \sqrt{81 + 25} = 10 \cdot \sqrt{106} = 10 \cdot 10.29563 \dots = 102.95630 \dots \approx 103.</math>”</p> <p><b>OR</b></p> <p>½ point</p> <ul style="list-style-type: none"> <li>• Correct length not rounded to the nearest mile Correct procedure shown and/or explained</li> <li>• Correct length Procedure is missing or incomplete</li> <li>• Student finds length from A to B, but does not multiply by <b>10</b>. Correct incomplete procedure is shown and/or explained May or may not be rounded or truncated to the nearest mile.</li> <li>• Incorrect or missing length Work may have a calculation, copy, or rounding error, early rounding, or truncation. Correct procedure is shown and/or explained May or may not be rounded or truncated to the nearest mile.</li> </ul>

# ITEM A SOLUTION AND SCORING—2014 GEOMETRY

Part	Points
2	<p><b>1 point possible:</b></p> <p>1 point: Correct slope: <math>-\frac{9}{5}</math></p> <p>Correct procedure is shown and/or explained Give credit for the following or equivalent:</p> <ul style="list-style-type: none"> <li>• <math>m = \frac{7-2}{3-6} = \frac{5}{-9}</math></li> <li>• <math>m = \text{negative reciprocal} = -\frac{9}{5}</math></li> <li>• <math>\frac{\text{rise}}{\text{run}} = \frac{5}{-9}</math></li> <li>• Shows counting <b>up 5</b> and <b>right 9</b>.</li> </ul> <p><b>OR</b></p> <p>½ point</p> <ul style="list-style-type: none"> <li>• Correct slope</li> <li>• Procedure is missing or incomplete</li> <li>• Incorrect or missing slope</li> <li>• Correct procedure is shown and/or explained</li> <li>• Work may have a calculation or copy error.</li> </ul>
3	<p><b>2 points possible:</b></p> <p>2 points: Correct equation: <math>y = -\frac{9}{5}x + 7</math></p> <p><i>(or correct equation for an incorrect slope in Part 2)</i> Correct procedure is shown and/or explained Give credit for the following or equivalent:</p> <ul style="list-style-type: none"> <li>• <math>y = mx + b \Rightarrow -2 = -\frac{9}{5}(5) + b = -9 + b \Rightarrow -2 + 9 = 7 = b</math> <math>y = -\frac{9}{5}x + 7</math></li> <li>• <math>(y - y_1) = m(x - x_1) \Rightarrow y - 2 = -\frac{9}{5}(x - 5) \Rightarrow y + 2 = -\frac{9}{5}x + 9 \Rightarrow y = -\frac{9}{5}x + 7</math></li> <li>• All three forms are acceptable.</li> <li>• Shows counting <b>up 9</b> and <b>left 5</b> to find the <b>y</b>-intercept.</li> </ul> <p><b>OR</b></p> <p>1 point</p> <ul style="list-style-type: none"> <li>• Correct equation</li> <li>• Procedure is missing or incomplete</li> <li>• Incorrect or missing equation</li> <li>• Work may have a calculation or copy error.</li> <li>• Correct procedure is shown and/or explained</li> </ul>

ITEM A SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 4

<u>Part 1</u>		Points
Correct Length:	103 miles	1
Correct Procedure:	$d = \sqrt{(-6-3)^2 + (2-7)^2} = \sqrt{(-9)^2 + (-5)^2} = \sqrt{81+25} = 10.29$ ; $10.29 \cdot 10 = 103$	
<u>Part 2</u>		Points
Correct Slope:	$-\frac{9}{5}$	1
Correct Procedure:	$m = \frac{7-2}{3-(-6)} = \frac{5}{9}$ ; "In order to be perpendicular to slope of $\overline{AB}$ ( $\frac{5}{9}$ ) the slope must be opposite and reciprocal ( $-\frac{9}{5}$ )."	
<u>Part 3</u>		Points
Correct Equation:	$y = -\frac{9}{5}x + 7$	2
Correct Procedure:	$y - (-2) = -\frac{9}{5}(x-5)$ ; $y + 2 - 2 = -\frac{9}{5}x + 9 - 2$ ; $y = -\frac{9}{5}x + 7$	
<b>Total Points</b>		<b>4</b>

①  $d = \sqrt{(x_2-x_1)^2 + (y_2-y_1)^2}$   
 $d = \sqrt{(-6-3)^2 + (2-7)^2}$   
 $d = \sqrt{(-9)^2 + (-5)^2}$   
 $d = \sqrt{81+25}$   
 $d = 10.29 \text{ units.}$   
 $10.29 \cdot 10 \text{ miles} = 103 \text{ miles}$

The road is 103 miles

②  $m = \frac{y_2-y_1}{x_2-x_1}$      $m = \frac{7-2}{3-(-6)} = \frac{5}{9} = \frac{5}{9} = \text{slope of } \overline{AB}$   
 The slope of  $\overline{CD}$  is  $-\frac{9}{5}$ . In order to be perpendicular to slope of  $\overline{AB}$  ( $\frac{5}{9}$ ) the slope must be opposite and reciprocal ( $-\frac{9}{5}$ ).

③  $y - y_1 = m(x - x_1)$   
 $y - (-2) = -\frac{9}{5}(x - 5)$   
 $y + 2 = -\frac{9}{5}x + 9$   
 $\quad \quad \quad -2$   
 $\hline y = -\frac{9}{5}x + 7$

The equation of the line that passes through point  $(5, -2)$  and has a slope of  $(-\frac{9}{5})$  is  $y = -\frac{9}{5}x + 7$ .

ITEM A SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 3

<b>Part 1</b>		<b>Points</b>
Correct Length:	103 miles	1
Correct Procedure:	$d = \sqrt{(3+6)^2 + (7-2)^2} = \sqrt{106} \approx 10.29$ ; $(10.29)(10) = 103$	
<b>Part 2</b>		<b>Points</b>
Incorrect Slope:	$-\frac{8}{5}$	$\frac{1}{2}$
Correct Procedure with calculation error:	$\frac{7-2}{3+6} = \frac{5}{8}$ [calculation error: should be $\frac{7-2}{3+6} = \frac{5}{9}$ ]; $-\frac{8}{5}$	
<b>Part 3</b>		<b>Points</b>
Correct Equation for incorrect Part 2:	$y = -\frac{8}{5}x + 6$	2
Correct Procedure:	$-2 - b = (-\frac{8}{5})(5) + b - b$ ; $-b - 2 + 2 = (-\frac{8}{5})(5) + 2$ ; $-b = -6$ ; $b = 6$	
<b>Total Points</b>		<b>3½</b>

$$D = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$= \sqrt{(3+6)^2 + (7-2)^2}$$

$$= \sqrt{106}$$

$$\approx 10.29$$

$$(10.29)(10) = \boxed{103 \text{ miles}}$$

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$= \frac{7-2}{3+6}$$

$$= \frac{5}{9}$$

new slope =  $\boxed{-\frac{8}{5}}$

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$$y = mx + b$$

$$-2 = (-\frac{8}{5})(5) + b$$

$$-b - 2 = (-\frac{8}{5})(5) + 2$$

$$-b = (-\frac{8}{5})(5) + 2$$

$$b = 6$$

$$\boxed{y = -\frac{8}{5}x + 6}$$

1.2.  
3.

ITEM A SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 2

<b>Part 1</b>		Points
Incorrect Length:	100 miles	½
Correct Procedure with truncation:	$\sqrt{(3-6)^2 + (7-2)^2} = \sqrt{(9)^2 + (5)^2} = \sqrt{106} = 10.2 = 10$ [truncation: = 10.2 = 10 should be = 10.29563...]; $10 \times 10 = 100$	
<b>Part 2</b>		Points
Correct Slope:	$-\frac{9}{5}$	1
Correct Procedure:	Counting <b>up 5</b> and <b>right 9</b> indicated on the student's diagram.	
<b>Part 3</b>		Points
Incorrect Equation:	$y = \frac{-9}{5}x + 11$	1
Correct Procedure with copy error:	$2 = \frac{-9}{5}(5) + b$ [copy error: should be $-2 = \frac{-9}{5}(5) + b$ ]; $2 = \frac{-45}{5} + b$ ; $2 + 9 = -9 + 9 + b$ ; $11 = b$ ; $y = \frac{-9}{5}x + 11$	
<b>Total Points</b>		<b>2½</b>

1.  $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$   
 $d = \sqrt{(3 - 6)^2 + (7 - 2)^2}$   
 $d = \sqrt{(9)^2 + (5)^2}$   
 $d = \sqrt{106}$   
 $d = 10.2 \approx 10$       $d = 10 \times 10 \text{ miles} = 100 \text{ miles}$

The unit length in miles of the road represented by AB is 100 miles.

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2. The slope of AB is  $\frac{9}{5}$       $\overline{AB} \text{ } y = \frac{9}{5}x + 9$       $\perp$       $\overline{CD} \text{ } y = -\frac{5}{9}x + 9$

If  $\overline{CD}$  will be perpendicular to  $\overline{AB}$ , then the slope of  $\overline{CD}$  is  $-\frac{5}{9}$ .

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3.  $\overline{CD} \text{ } y = -\frac{9}{5}x + 11$      Pass through  $(5, -2)$

$-2 = -\frac{9}{5}(5) + b$      The equation for  $\overline{CD}$  is  $y = -\frac{9}{5}x + 11$ .  
 $-2 = -\frac{45}{5} + b$   
 $-2 = -9 + b$       $11 = b$

ITEM A SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 1

<b>Part 1</b>		<b>Points</b>
Incorrect Length:	102.95 miles	½
Correct Procedure with truncation:	$\sqrt{(3-6)^2 + (7-2)^2}$ ; $\sqrt{81+25}$ ; $\sqrt{106} = 10.29$ [= 10.29 is OK internal work; student later used the calculator value]; $10.29 \times 10 = 102.95$ [truncation: = 102.95 SB = 10.29563... ≈ 103]	
<b>Part 2</b>		<b>Points</b>
Incorrect Slope:	$-\frac{3}{2}$	0
Incorrect Procedure:	$\frac{(1-10)}{(7-1)} = \frac{-9}{6} = -\frac{3}{2}$ ; There is no indication as to how the incorrect points were determined.	
<b>Part 3</b>		<b>Points</b>
Incorrect Equation:	$y = \frac{-3}{2}x - \frac{19}{2}$	1
Correct Procedure for incorrect Part 2, with calculation error:	$-2 = -\frac{3}{2}(5) + b$ ; $-2 = \frac{-15}{2} + b$ ; $\frac{-19}{2} = b$ [calculation error: should be $\frac{-11}{2} = b$ ]; $y = \frac{-3}{2}x - \frac{19}{2}$	
<b>Total Points</b>		<b>1½</b>

$$\textcircled{1} \sqrt{(3-6)^2 + (7-2)^2}$$

$$\sqrt{81+25}$$

$$\sqrt{106} = 10.29$$

$$10.29 \times 10 = 102.95 \text{ miles}$$

$$\textcircled{2} C(1,10) \quad \frac{(1-10)}{(7-1)} = \frac{-9}{6} = -\frac{3}{2}$$

$$D(7,1)$$

$$\text{slope of } \overline{CD} = -\frac{3}{2}$$

$$\textcircled{3} -2 = -\frac{3}{2}(5) + b$$

$$-2 = \frac{-15}{2} + b$$

$$\frac{-19}{2} = b \quad y = \frac{-3}{2}x - \frac{19}{2}$$

ITEM A SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 0

<b>Part 1</b>		<b>Points</b>
Two Incorrect Answers:	3.2 miles; (-1.5, 4.5)	0
Two Incorrect Procedures:	Attempts to find length and also finds the midpoint.	
<b>Part 2</b>		<b>Points</b>
Incorrect Slope:	$\frac{5}{9}$	0
Incomplete Procedure:	$\frac{7-2}{3-6} = \frac{5}{9}$ Did not determine the negative reciprocal.	
<b>Part 3</b>		<b>Points</b>
Incorrect Answer:	-1	0
Incorrect Procedure:	$y = \frac{-2-4.5}{5-1.5} = \frac{-6.5}{6.5} = -1$ Finds the slope between (-1.5, 4.5) and (5, -2).	
<b>Total Points</b>		<b>0</b>

$$1. d = \sqrt{(3-6)^2 + (7-2)^2}$$

$$d = \sqrt{10.89 + 25} = 3.2$$

$$d = 3.2 \text{ miles}$$

or  $\left(\frac{3+6}{2}, \frac{7+2}{2}\right)$   
 $(-1.5, 4.5)$

$$2. y = mx + b$$

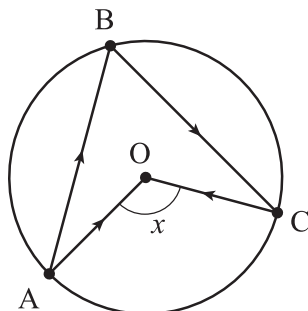
$$m = \frac{7-2}{3-6} = \frac{5}{9} \text{ or } \dots$$

$$3. m = \frac{-2-4.5}{5-1.5} = \frac{-6.5}{6.5} = -1$$

so  $\overline{AB}$  is parallel or congruent to  $\overline{CD}$ .

## ITEM B—2014 GEOMETRY

- B. A trophy and award company uses a laser to etch figures on award medals. A computer program directs the laser in the path shown in the diagram below. Point O is the center of the circle, and points A, B, and C all lie on the circle.



1. The laser etches a  $60^\circ$  angle at B. What is  $m\angle x$ ? Show your work and/or explain your answer.
2. If  $OC = 3$  cm, what is the length of  $\widehat{AC}$  to the nearest hundredth? Show your work and/or explain your answer.

BE SURE TO LABEL YOUR RESPONSES 1 AND 2.

### Item B Scoring Rubric—2014 Geometry

Score	Description
4	The student earns 4 points. The response contains no incorrect work. <b>Degree</b> needed in Part 1 and <b>cm</b> needed in Part 2.
3	The student earns 3 – $3\frac{1}{2}$ points.
2	The student earns 2 – $2\frac{1}{2}$ points.
1	The student earns 1 – $1\frac{1}{2}$ points, or some minimal understanding is shown.
0	The student earns 0 points. No understanding is shown.
B	Blank — No Response. A score of “B” will be reported as “NA.” (No attempt to answer the item. Score of “0” is assigned for the item.)



SOLUTION AND SCORING

Do not deduct for early rounding or truncating in internal work that results in the correct answer. Students may write these values for brevity, using the exact calculator value to find their answer.

4 points possible:

Part	Points
1	<p><b>2 points possible:</b></p> <p>2 points: Correct angle measure: <math>m\angle x = 120^\circ</math> (<i>degrees is required for a 4</i>)            Correct procedure is shown and/or explained            Give credit for the following or equivalent:</p> <p>Ex. The measure of an inscribed angle equals one-half the measure of the intercepted arc. The measure of a central angle equals the measure of the intercepted arc. Therefore, the measure of an inscribed angle is one-half the measure of a central angle that intercepts the same or congruent arcs or</p> $60 = \frac{1}{2} \cdot m\angle x \text{ which means } m\angle x = 60 \cdot 2 = 120^\circ .$ <p>Ex. <math>m\angle B = \frac{1}{2} \cdot m\widehat{AC}</math> and <math>m\angle x = m\widehat{AC}</math></p> $m\angle B = \frac{1}{2} \cdot m\angle x \text{ by substitution}$ $60 = \frac{1}{2} \cdot m\angle x$ $m\angle x = 120^\circ$ <p>Ex. <math>60 = \frac{1}{2} \cdot m\angle x \Rightarrow m\angle x = 60 \cdot 2 = 120^\circ</math></p> <p><b>OR</b></p> <p>1 point</p> <ul style="list-style-type: none"> <li>• Correct angle measure: <math>120^\circ</math> Correct procedure is missing or incomplete</li> <li>• Angle measure is missing or incorrect Correct procedure is shown and/or explained</li> </ul>

**ITEM B SOLUTION AND SCORING—2014 GEOMETRY**

Part	Points
2	<p><b>2 points possible:</b></p> <p>2 points: Correct arc length: <b>6.28 cm</b> (<i>centimeters is required for a 4</i>)  <i>(or correct arc length based on an incorrect angle measure from Part 1)</i>            Correct procedure is shown and/or explained            Give credit for the following or equivalent:</p> <p>Ex. Arc Length = <math>\frac{n}{360}(2\pi r) = \frac{120}{360}(2)(\pi)(3) = 2\pi = 6.28318\dots \approx 6.28</math></p> <p>Ex. Arc Length = <math>\frac{n}{360}(2\pi r) = \frac{120}{360}(2)(3.14)(3) = \frac{1}{3}(6.28)(3) = 6.28</math></p> <p>Ex. A circle has 360 degrees and since <math>m\angle x = 120</math>,            arc AC must be <math>\frac{120}{360}</math> or <math>\frac{1}{3}</math> of the entire circle.            The radius of the circle is 3 cm, so its circumference is equal to <math>6\pi</math>.            The length of <math>\widehat{AC}</math> is <math>\frac{1}{3}</math> of <math>6\pi</math> or <math>2\pi</math> (approximately 6.28 cm).</p> <p>Ex. <math>\pi</math> radians = <math>180^\circ \Rightarrow 120^\circ \cdot (\pi / 180) = \frac{2}{3}\pi</math> radians</p> $s = r\theta = 3 \cdot \frac{2}{3}\pi = 2\pi = 2 \cdot 3.14159\dots = 6.28318\dots \approx 6.28$ <p><b>OR</b></p> <p>1½ points: Correct arc length but is rounded to a place other than the nearest 100<sup>th</sup> or truncated,            or is incorrect due to early rounding  <i>(or correct arc length based on an incorrect angle measure from Part 1)</i>            Correct procedure is shown and/or explained</p> <p><b>OR</b></p> <p>1 point</p> <ul style="list-style-type: none"> <li>• Correct arc length: <b>6.28</b>            Correct procedure is missing or incomplete</li> <li>• Arc length is missing            Correct procedure is shown and/or explained</li> <li>• Arc length is incorrect due to calculation, copy, or rounding error  <i>(may or may not be rounded to the nearest 100<sup>th</sup>)</i>            Correct procedure is shown and/or explained</li> </ul>

ITEM B SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 4

<b>Part 1</b>		<b>Points</b>
Correct Measure:	120°	2
Correct Explanation:	“∠ABC & ∠x have the same arc ( $\widehat{AC}$ ). ... ∠B is an inscribed angle, which means it's arc is the measure of the angle ×2. ... ∠x is a central angle, which means it's arc is the same measure of the angle.”	
<b>Part 2</b>		<b>Points</b>
Correct Length:	6.28 cm	2
Correct Procedure:	$\left(\frac{120}{360}\right) \times 2\pi(3)$ ; 6.28...	
<b>Total Points</b>		<b>4</b>

①  
 $\angle ABC$  &  $\angle x$   
 have the same  
 arc ( $\widehat{AC}$ ). Their  
 points both  
 connect at point  
 A & point C.  $\angle B$   
 is an inscribed  
 angle, which means  
 it's arc is the  
 measure of the angle  
 ×2. So if  $\angle B$  is  $60^\circ$ , the arc is  $120^\circ$ .  $\angle x$  is a central  
 angle, which means it's arc is the same measure of the angle.  
 So if  $\widehat{AC}$  is  $120^\circ$ , then the measure of  $\angle x$  is  $120^\circ$ .

~~.....~~

② Arc length =  $\left(\frac{m}{360}\right) \times 2\pi r$  (m = measure of arc)


So.. since the measure of  $\widehat{AC}$  is 120, then you would  
 do:  $\left(\frac{120}{360}\right) \times 2\pi(3)$ , since the radius ( $OC$ ) is 3 cm.  
 The answer is 6.28... So the length of  $\widehat{AC}$  is 6.28 cm.

**ITEM B SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY**


**SCORE POINT: 3**

<b>Part 1</b>		<b>Points</b>
Correct Measure:	120°	2
Correct Explanation:	“Since it is 2 times the size of 60°.”	
<b>Part 2</b>		<b>Points</b>
Incorrect Length:	6.9	1
Correct Procedure with calculation error:	$\left(\frac{120}{360}\right) \cdot 2\pi(3)$ ; 6.9 [SB 6.28318... $\approx$ 6.28]	
<b>Total Points</b>		<b>3</b>

1) The m $\angle$  would be 120°. Since it is 2 times the size of 60°.



2) arc length =  $\left(\frac{\pi}{360}\right) \cdot 2\pi r$   
 length =  $\left(\frac{120}{360}\right) \cdot 2\pi(3)$   
 length = 6.9 cm



The length of  $\widehat{ac}$  is 6.9 cm.

**ITEM B SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY**

**SCORE POINT: 2**

<b>Part 1</b>		<b>Points</b>
Correct Measure:	120°	2
Correct Procedure:	2•60 = 120	
<b>Part 2</b>		<b>Points</b>
Incorrect Length:	25.13 cm	0
Incorrect Procedure:	$\left(\frac{160}{360}\right) \times 2\pi 3^2 = 25.13$ There is no indication of how the incorrect <b>160</b> was determined. <b>3<sup>2</sup></b> is incorrect. Either mistake alone is enough for no credit due to an incorrect procedure.	
<b>Total Points</b>		<b>2</b>

1)  $2 \cdot 60 = 120$

$x = 120^\circ$

2)  $\widehat{AC} = 25.13 \text{ cm}$

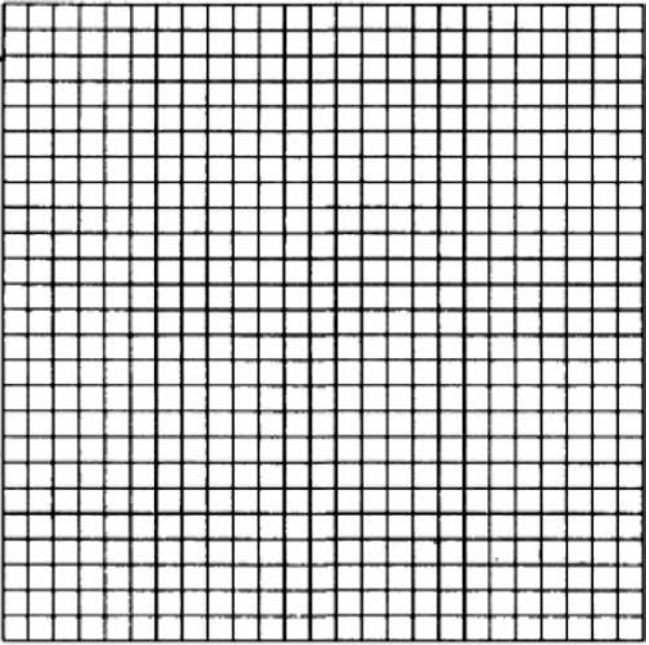
$\left(\frac{160}{360}\right) \times 2\pi 3^2 = 25.13$

**ITEM B SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY**

**SCORE POINT: 1**

<b>Part 1</b>		<b>Points</b>
Incorrect Measure:	110°	0
Incorrect Explanation:	"It is more than 90°. My approx. guess is about $x=110^\circ$ "	
<b>Part 2</b>		<b>Points</b>
Correct Length for incorrect Part 1:	5.75 cm	1½
Correct Procedure with truncation for incorrect Part 1:	$\frac{110}{360} \times 2\pi r$ ; 5.75 [Truncated from 5.75958...]	
<b>Total Points</b>		<b>1½</b>

① whole inside circle is 360°.  $x$  is a big portion of the circle with a major Arc. It's more than 90°. My approx. guess is about  $x = 110^\circ$ .



② Arc length =  $\frac{M}{360} \times 2\pi r$   
 $\frac{110}{360} \times 2\pi r = \text{Arc length}$   
 Arc length = 5.75 cm

ITEM B SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 0

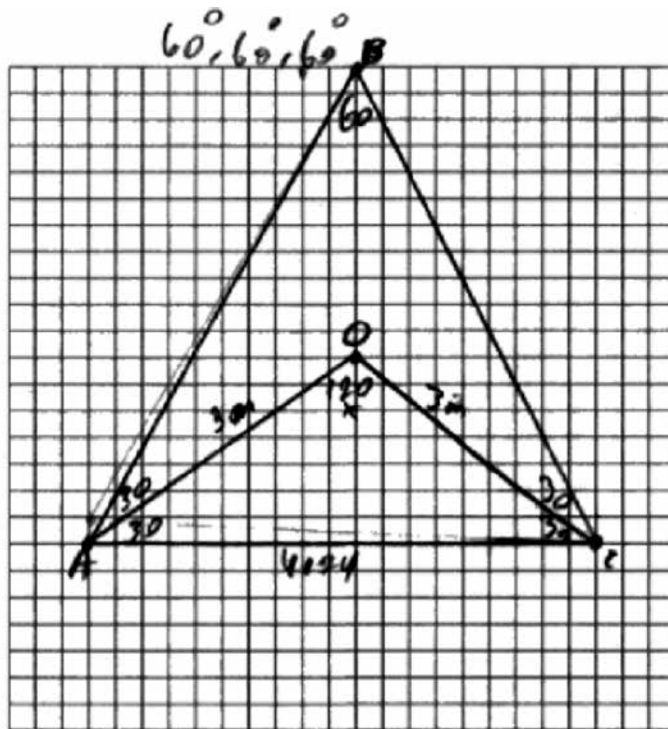
**Part 1**

		Points
Correct Measure:	120°	0
Incorrect Procedure:	From the diagram, presumes an equilateral triangle. No credit for a correct answer due to an incorrect procedure.	

**Part 2**

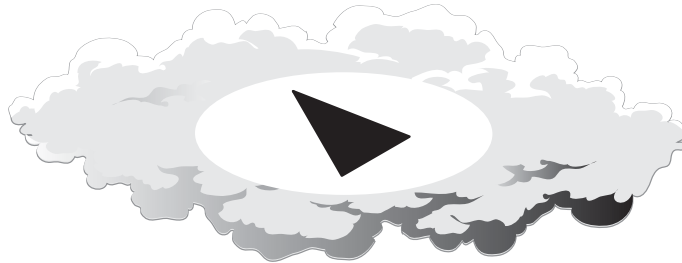
		Points
Incorrect Length:	4.29	0
Incorrect Procedure:	Attempts to use the Pythagorean Theorem.	
<b>Total Points</b>		<b>0</b>

$W/LX = 120$   
 $2) 3^2 + 3^2 = 1^2$   
 $9 + 9 = \sqrt{18}$   
 $\sqrt{18} = (4.29)$



## ITEM C—2014 GEOMETRY

- C. A spotlight projects a triangular shape onto a cloud.



1. The side lengths of a triangle projected on a cloud are 16 feet, 16 feet, and 20 feet. The longest side of the triangle on the spotlight is 0.5 feet long. What is the perimeter of the triangle on the spotlight? Show your work and/or explain your answer.
2. The spotlight operator has a second triangular template that he can use on the spotlight. The perimeter of the new triangle is 2 feet. What is the perimeter of the triangle the second template would project onto the same cloud? Show your work and/or explain your answer.

BE SURE TO LABEL YOUR RESPONSES 1 AND 2.

### Item C Scoring Rubric—2014 Geometry

Score	Description
4	The student earns 4 points. The response contains no incorrect work. <b>Feet</b> label required in Parts 1 and 2.
3	The student earns 3 – 3½ points.
2	The student earns 2 – 2½ points.
1	The student earns ½ – 1½ points, or some minimal understanding is shown.
0	The student earns 0 points. No understanding is shown.
B	Blank — No Response. A score of “B” will be reported as “NA.” (No attempt to answer the item. Score of “0” is assigned for the item.)



**SOLUTION AND SCORING**

For this item, it is acceptable for students to write a scale factor. Ex:  $0.5' = 20'$

4 points possible:

Part	Points
<b>1</b>	<p><b>2 points possible:</b></p> <p>2 points: Correct perimeter: <b>1.3 feet</b> (<i>feet required for a 4</i>)                      Correct procedure is shown and/or explained                      Give credit for the following or equivalent:</p> <ul style="list-style-type: none"> <li>• Find the missing sides first                             <math display="block">\frac{0.5}{20} = \frac{x}{16}</math> <math display="block">20x = 8</math> <math display="block">x = 0.4 \text{ feet}</math> <math display="block">P = 0.4 + 0.4 + 0.5 = 1.3 \text{ feet}</math> </li> <li>• Ratio of sides = ratio of perimeter                             <math display="block">\frac{0.5}{20} = \frac{x}{16 + 16 + 20}</math> <math display="block">\frac{0.5}{20} = \frac{x}{52}</math> <math display="block">20x = 26</math> <math display="block">x = 1.3 \text{ feet}</math> </li> </ul> <p><b>OR</b></p> <p>1 point</p> <ul style="list-style-type: none"> <li>• Correct Perimeter: 1.3                              Procedure is missing or incomplete</li> <li>• Incorrect perimeter due to a calculation, copy, rounding, or truncation error                              Correct procedure is shown and/or explained</li> <li>• Missing Perimeter                              Correct procedure is shown and/or explained</li> <li>• Finds <math>x = 0.4</math> feet                              Correct procedure is shown and/or explained</li> </ul> <p><b>OR</b></p> <p>½ point</p> <ul style="list-style-type: none"> <li>• Finds <math>x = 0.4</math> feet                              Procedure is missing or incomplete</li> <li>• Sets up correct proportion                              Answer and procedure may be missing, incomplete, or incorrect.                              Give credit for the following or equivalent:  <math display="block">\frac{0.5}{20} = \frac{x}{16} \text{ or } \frac{0.5}{20} = \frac{x}{52} \text{ or } \frac{x}{0.5} = \frac{16}{20}</math> </li> </ul>

**ITEM C SOLUTION AND SCORING—2014 GEOMETRY**

Part	Points
2	<p><b>2 points possible:</b></p> <p>2 points: Correct perimeter: <b>80 feet</b> (<i>feet required for a 4</i>)  <i>(or correct perimeter based on an incorrect perimeter in Part 1)</i>            Correct procedure is shown and/or explained            Give credit for the following or equivalent:</p> <ul style="list-style-type: none"> <li>• <math>\frac{0.5}{20} = \frac{2}{x}</math>  <math>0.5x = 40</math>  <math>x = 80</math> feet</li> <li>• <math>\frac{1.3}{16+16+20} = \frac{2}{x}</math>  <math>1.3x = 52(2)</math>  <math>x = 80</math> feet</li> <li>• <math>\frac{20}{.5} = \frac{x}{2}</math>  <math>\frac{20}{.5} = 40 \Rightarrow x = 2 \cdot 40 = 80</math></li> </ul> <p><b>OR</b></p> <p>1 point</p> <ul style="list-style-type: none"> <li>• Correct perimeter: 80 feet            Procedure is missing or incomplete</li> <li>• Incorrect perimeter due to a calculation, copy, rounding error, or early rounding  <i>(or incorrect perimeter based on an incorrect perimeter in Part 1)</i>            Correct procedure is shown and/or explained</li> <li>• Missing perimeter            Correct procedure is shown and/or explained</li> </ul> <p><b>OR</b></p> <p>½ point</p> <ul style="list-style-type: none"> <li>• Sets up correct proportion            Answer and procedure may be missing, incomplete, or incorrect.            Give credit for the following or equivalent:  <math>\frac{0.5}{20} = \frac{2}{x}</math> <b>or</b> <math>\frac{1.3}{52} = \frac{2}{x}</math> <b>or</b> <math>\frac{20}{0.5} = \frac{x}{2}</math></li> </ul>

ITEM C SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 4

<b>Part 1</b>		<b>Points</b>
Correct Perimeter:	1.3 ft.	2
Correct Procedure:	$\frac{20}{.5} = \frac{16}{x}; \frac{20x}{8} = \frac{8}{8}; x = 0.4; 0.5 + 0.4 + 0.4 = 1.3$ The work shows cross-multiplication; it is not crossed out.	
<b>Part 2</b>		<b>Points</b>
Correct Perimeter:	80 ft.	2
Correct Procedure:	$\frac{52}{1.3} = \frac{x}{2}; \frac{104}{1.3} = \frac{1.3x}{1.3}; x = 80$ The work shows cross-multiplication; it is not crossed out.	
<b>Total Points</b>		<b>4</b>

①

~~$\frac{20}{.5} = \frac{16}{x}$~~

$\frac{20x}{8} = \frac{8}{8}$

$x = 0.4$

$0.5 + 0.4 + 0.4 = 1.3$

The perimeter of the triangle on the spot is 1.3 ft.

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②

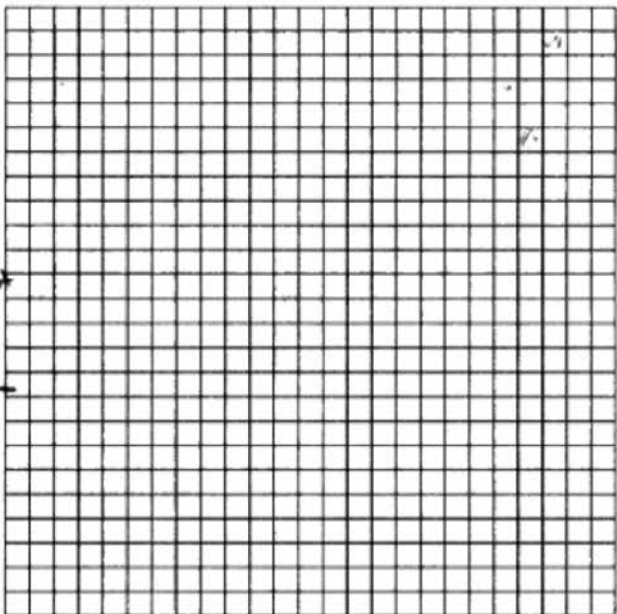
$10 + 16 + 20 = 52$

~~$\frac{52}{1.3} = x$~~

$\frac{104}{1.3} = \frac{1.3x}{1.3}$

$x = 80$

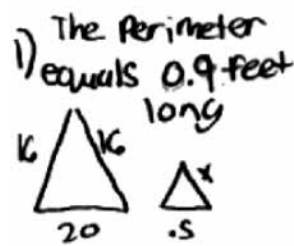
The perimeter of the triangle in the clouds using the new template would be 80 ft.



ITEM C SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 3

<b>Part 1</b>		Points
Incorrect Perimeter:	.9	1
Correct Procedure with calculation error:	$\frac{.5}{20} = \frac{x}{16}$ ; $20x = .5(16)$ ; $\frac{20x = 8}{20}$ ; $x = \frac{8}{20}$ ; $x = \frac{1}{5}$ [calculation error: $\frac{1}{5}$ SB $\frac{2}{5}$ ]; $x = .2$ ; $.2 + .2 + .5$	
<b>Part 2</b>		Points
Correct Perimeter for incorrect Part 1:	115.6	2
Correct Procedure:	$\frac{.9}{.2} = \frac{52}{x}$ ; $x \cdot 9 = 104$ ; $x = 115.6$ [115.6 is rounded from 115.5]	
<b>Total Points</b>		<b>3</b>



$$\frac{.5}{20} = \frac{x}{16}$$

$$20x = .5(16)$$

$$20x = 8$$

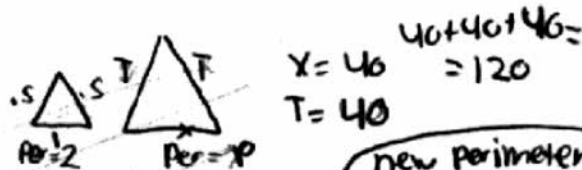
$$x = \frac{8}{20}$$

$$x = \frac{2}{5}$$

$x = .2$

Per =  $.2 + .2 + .5$   
Per = .9

2)



$$\frac{.9}{2} = \frac{52}{x}$$

$$x \cdot 9 = 104$$

$$x = 115.6$$

$$16 \div .2 = 80$$

$$20 \div .5 = 40$$

$$.5(80) = T$$

$$1(40) = x$$

$$x = 115.6$$

new perimeter equals 115.6

$$\frac{.9}{2} = \frac{52}{x}$$

$$x \cdot 9 = 104$$


$$x = 115.6$$

If this had been a 4 paper, the impossible “.5-.5-1” triangle in Part 2 would reduce the score to 3.

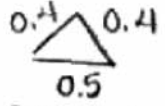
ITEM C SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 2

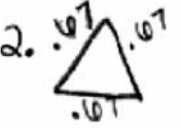
<u>Part 1</u>		Points
Correct Perimeter:	1.3	2
Correct Procedure:	$\frac{16}{20} = \frac{x}{0.5}$ ; $20x = 8$ ; $20x = 8$ ; $x = 0.4$ ; $.4 + .4 + .5 = 1.3$	
<u>Part 2</u>		Points
Incorrect Perimeter:	73.8	0
Incorrect Procedure:	$\frac{1.3}{48} = \frac{2}{x}$ [procedure error: does not indicate how the incorrect <b>48</b> was determined]; $1.3x = 96$ ; $x = 73.8$	
<b>Total Points</b>		<b>2</b>

1. 

$\frac{16}{20} = \frac{x}{0.5}$   $20x = 8$   
 $x = 0.4$



$0.4 + 0.4 + 0.5 = 1.3 \text{ ft}$   
**Perimeter = 1.3 ft**

2. 

$\frac{1.3}{48} = \frac{2}{x}$   
**perimeter = 73.8 ft**

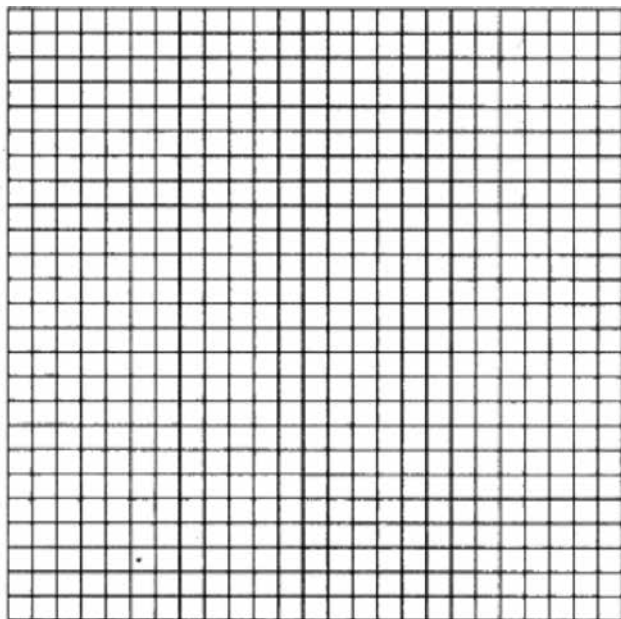
the perimeter of the second template when projected into the clouds is 73.8ft. I crossed multiply the perimeter of the 2nd template and perimeters in part 1 to see how they compare to get the perimeter of the template when used on the clouds.

ITEM C SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 1

<b>Part 1</b>		<b>Points</b>
Incorrect Perimeter:	1.6	1
Correct Procedure with calculation error:	$\frac{.5}{20} = 0.025$ ; $0.025 \times 20 = .5$ ; $0.025 \times 16 = .4$ ; $0.025 \times 16 = .4$ ; $0.5 + 0.4 + 0.4 = 1.6$ ; [calculation error: SB $0.5 + 0.4 + 0.4 = 1.3$ ]	
<b>Part 2</b>		<b>Points</b>
Incorrect Perimeter:	2	0
Incorrect Explanation:	"The new triangles measures would be .5, .5, .7 this added up equals 2 in" Determined the second-template perimeter, with a calculation error.	
<b>Total Points</b>		<b>1</b>

$\frac{.5}{20} = 0.025$   
 $0.025 \times 20 = .5$   
 $0.025 \times 16 = .4$   
 $0.025 \times 16 = .4$   
 $\begin{array}{r} .5 \\ +.4 \\ +.4 \\ \hline 1.6 \end{array}$  1.6 is;  
 the perimeter  
 2 The new  
 triangles measures would  
 be .5, .5, .7 this added up  
 equals 2 in.



ITEM C SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 0

<u>Part 1</u>		Points
Incorrect Perimeter:	39	0
Incorrect Procedure:	Attempt to find the ratio of volumes.	
<u>Part 2</u>		Points
Missing Perimeter:	The final answer is not specified.	0
Incorrect Procedure:	Performs random calculations.	
<b>Total Points</b>		<b>0</b>

1.

$$V = LWh$$

$$V = 16 \cdot 16 \cdot 20$$

$$V = 5120 \text{ Ft}^3$$

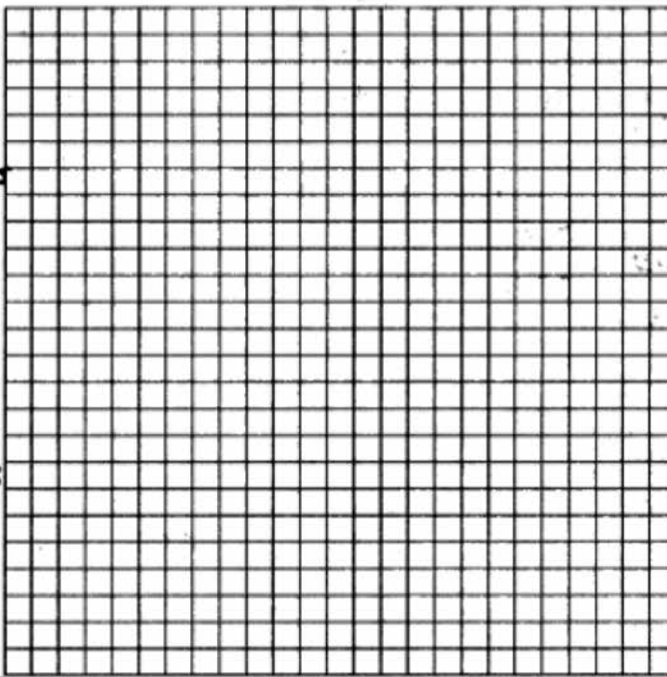
$$V = LWh$$

$$V = 16 \cdot 16 \cdot 25$$

$$V = 128 \text{ Ft}^3$$

$$\begin{array}{r} 5120 \\ - 128 \\ \hline 4992 \text{ Ft}^3 \end{array}$$

$$\begin{array}{r} 5120 \\ - 4992 \\ \hline 128 \text{ Ft}^3 \end{array}$$

$$4992 / 128 = 39 \text{ Ft}^3$$


2.

$$V = LWh$$

$$V = 0.5 \cdot 2 \cdot 20$$

$$V = 20 \text{ Ft}^3$$

$$\begin{array}{r} 640 \\ - 20 \\ \hline 620 \text{ Ft}^3 \end{array}$$

$$L = LWh$$

$$V = 2 \cdot 16 \cdot 20$$

$$V = 640 \text{ Ft}^3$$

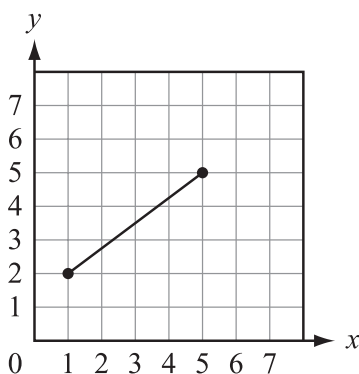
$$\begin{array}{r} 640 \\ \div 16 \\ \hline 40 \text{ Ft}^3 \end{array}$$

$$16 + 16 + 2 + 20 + 0.5 = 54.5 \text{ Ft}^3$$

$$\begin{array}{r} 640 \\ - 54.5 \\ \hline 585.5 \text{ Ft}^3 \end{array}$$

## ITEM D—2014 GEOMETRY

- D. A carpenter wants to cut a board, represented by the segment shown on the graph below, into two equal pieces.



1. What point on the graph represents where the carpenter should cut the board? Show your work.
2. The carpenter needs to make the cut perpendicular to the board. What is the equation of the line representing the perpendicular bisector of the board on the graph? Show your work.

BE SURE TO LABEL YOUR RESPONSES 1 AND 2.

### Item D Scoring Rubric—2014 Geometry

Score	Description
4	The student earns 4 points. The response contains no incorrect work.
3	The student earns 3 points.
2	The student earns 2 points.
1	The student earns 1 point, or some minimal understanding is shown.
0	The student earns 0 points. No understanding is shown.
B	Blank — No Response. A score of “B” will be reported as “NA.” (No attempt to answer the item. Score of “0” is assigned for the item.)



**SOLUTION AND SCORING**

**Board-Segment Endpoints:**            **(1,2)    (5,5)**

**4 points possible:**

Part	Points
<b>1</b>	<p><b>2 points possible:</b></p> <p>2 points:    Correct coordinates: <math>\left(3, \frac{7}{2}\right)</math> or <math>(3, 3.5)</math> or <math>\left(3, 3\frac{1}{2}\right)</math></p> <p>Correct procedure is shown and/or explained Give credit for the following or equivalent:</p> <p>Ex. The carpenter should cut the board at the midpoint of the line segment representing the board.</p> $\left(\frac{1+5}{2}, \frac{2+5}{2}\right) = \left(3, \frac{7}{2}\right)$ <p>Therefore, the carpenter should cut the board at <math>\left(3, \frac{7}{2}\right)</math></p> <p>Ex. <math>\left(\frac{1+5}{2}, \frac{2+5}{2}\right) = (3, 3.5)</math></p> <p>Ex. “From (1,2) I counted right 2 units and up 1.5 units to (3, 3.5). From (3, 3.5) I counted right 2 units and up 1.5 units to (5, 5).”</p> <p><b>OR</b></p> <p>1 point</p> <ul style="list-style-type: none"> <li>• Correct Coordinates: <math>\left(3, \frac{7}{2}\right)</math> Procedure is missing or incomplete</li> <li>• Missing coordinates Correct procedure is shown and/or explained</li> <li>• Incorrect coordinates due to a calculation or copy error Correct procedure is shown and/or explained</li> <li>• One correct coordinate with the correct procedure shown. Other coordinate is missing or incorrect</li> <li>• Correct coordinates. Missing parenthesis Correct procedure is shown and/or explained</li> </ul>

**ITEM D SOLUTION AND SCORING—2014 GEOMETRY**

Part	Points
2	<p><b>2 points possible:</b></p> <p>2 points: Correct equation or equivalent equation: <math>y = -\frac{4}{3}x + \frac{15}{2}</math>  <i>(or correct equation based on an incorrect coordinate in Part 1)</i>            Correct procedure is shown and/or explained            Give credit for the following or equivalent:</p> <p>Ex. The slope of the board is <math>m = \frac{5-2}{5-1} = \frac{3}{4}</math></p> <p>The slope of the perpendicular bisector is <math>-\frac{4}{3}</math></p> <p>The line will pass through the midpoint of the segment found in Part 1.</p> $y - 3\frac{1}{2} = -\frac{4}{3}(x - 3)$ $y - 3\frac{1}{2} = -\frac{4}{3}x + 4$ $y = -\frac{4}{3}x + \frac{15}{2}$ <p>So, the carpenter should cut the board along the line <math>y = -\frac{4}{3}x + \frac{15}{2}</math></p> <p>Ex. <math>m_{\text{Board}} = \frac{5-2}{5-1} = \frac{3}{4} \Rightarrow m_{\perp\text{Bisector}} = -\frac{4}{3}</math></p> $\frac{7}{2} = -\frac{4}{3}(3) + b = -4 + b \Rightarrow \frac{7+8}{2} = \frac{15}{2} = b$ $\Rightarrow y = -\frac{4}{3}x + \frac{15}{2}$ <p><b>OR</b></p> <p>1 point</p> <ul style="list-style-type: none"> <li>• Correct equation: <math>y = -\frac{4}{3}x + \frac{15}{2}</math>  <i>(or correct equation based on an incorrect coordinate in Part 1)</i>            Procedure is missing or incomplete</li> <li>• Incorrect equation due to a calculation or copy error            Correct procedure is shown and/or explained</li> <li>• Correct equation with correct procedure            for an incorrect slope shown of the original board in Part 1.</li> </ul>

ITEM D SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 4

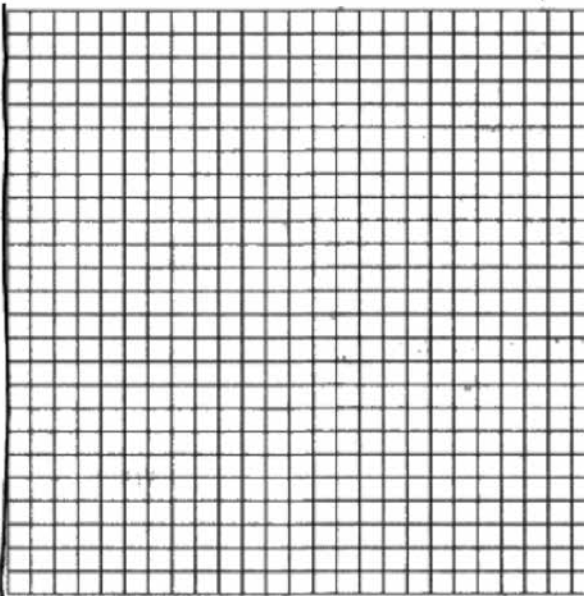
<u>Part 1</u>		Points
Correct Coordinates:	(3,3.5)	2
Correct Procedure:	$\left(\frac{5+1}{2}, \frac{5+2}{2}\right) = \left(\frac{6}{2}, \frac{7}{2}\right) = (3, 3.5)$	
<u>Part 2</u>		Points
Correct Equation:	$y = -\frac{4}{3}x + 7.5$	2
Correct Procedure:	$m = \frac{5-2}{5-1} = \frac{3}{4}$ ; $m = -\frac{4}{3}$ ; $3.5 = -\frac{4}{3}(3) + b$ ; $3.5 + 4 = -4 + 4 + b$ ; $b = 7.5$	
<b>Total Points</b>		<b>4</b>

①

$(1, 2) \quad (5, 5)$   
 $x_1, y_1 \quad x_2, y_2$

midpoint =  
 $\left(\frac{5+1}{2}, \frac{5+2}{2}\right) =$   
 $\left(\frac{6}{2}, \frac{7}{2}\right) =$   
 $(3, 3.5)$

The carpenter should cut the board at (3, 3.5).



②  $m = \text{slope}$   
 $(1, 2) \quad (5, 5)$   
 $x_1, y_1 \quad x_2, y_2$

$m = \frac{5-2}{5-1} = \frac{3}{4}$

$y = mx + b \quad (3, 3.5) \quad m = -\frac{4}{3}$   
 $3.5 = -\frac{4}{3}(3) + b$   
 $3.5 = -4 + b$   
 $+4 \quad +4$   
 $b = 7.5 \quad y = -\frac{4}{3}x + 7.5$

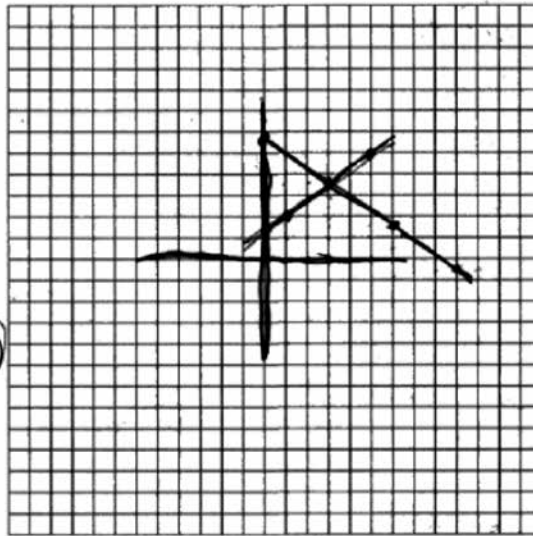
The perpendicular bisector's equation is  $y = -\frac{4}{3}x + 7.5$ .

ITEM D SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 3

<u>Part 1</u>		Points
Correct Coordinates:	(3,3.5)	2
Correct Procedure:	$\left(\frac{1+5}{2}, \frac{2+5}{2}\right); \frac{6}{2}, \frac{7}{2}$	
<u>Part 2</u>		Points
Correct Equation:	$y = \frac{-2}{3}x + 5.5$	1
Correct Procedure with calculation error:	$\frac{5-2}{5-1} = \frac{3}{2}$ [calculation error: should be $= \frac{3}{4}$ ]; opp recip $= \frac{-2}{3}$ ; $y - 3.5 = \frac{-2}{3}(x - 3)$ ; $y - 3.5 + 3.5 = \frac{-2}{3}x + 2 + 3.5$	
<b>Total Points</b>		<b>3</b>

$(1,2)$   ~~$(2,5)$~~   
 $(5,5)$   
 ① No  $\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$   
 $M = \left(\frac{1+5}{2}, \frac{2+5}{2}\right)$   
 $M = 3, \frac{7}{2}$   
 $M = (3, 3.5)$   
 The computer should cut the board at point  $(3, 3.5)$   
 If he wants to cut the board into two equal pieces he must cut at the midpoint



②  $(1,2)$   $\frac{y_2-y_1}{x_2-x_1} = \frac{5-2}{5-1} = \frac{3}{4}$  opp recip  $= \frac{-3}{4}$   
 $(5,5)$   
 Midpoint  $(3, 3.5)$   
 $y - 3.5 = \frac{-3}{4}(x - 3)$   
 $y - 3.5 = \frac{-3}{4}x + \frac{9}{4}$   
 $y = \frac{-3}{4}x + \frac{9}{4} + 3.5$   
 $y = \frac{-3}{4}x + 5.5$   
 $y =$   
 (An uncut board is perpendicular to the line)  
 To find the line we must find the slope of the original line then we must find the midpoint of the two original points (which we already have thanks to #1) once we have the midpoint and the slope opposite reciprocal we put it into point slope form  $(y - y_1) = m(x - x_1)$ . That should give us the equation of the line that is a perpendicular bisector.

ITEM D SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 2

<u>Part 1</u>		Points
Correct Coordinates:	(3,3.5)	2
Correct Procedure:	$\frac{5+1}{2}, \frac{5+2}{2}; \frac{6}{2}, \frac{7}{2}; 3, 3\frac{1}{2}$	
<u>Part 2</u>		Points
Incorrect Equation:	$y = \frac{-4}{3}x + 3\frac{1}{2}$	0
Incorrect Procedure:	Determined the slope of the perpendicular bisector and used the original board midpoint y-value for the y-intercept.	
<b>Total Points</b>		<b>2</b>

1.) midpoint  $(\frac{x_2 + x_1}{2}, \frac{y_2 + y_1}{2})$

first point 1,2      second point 5,5

$\frac{5+1}{2}, \frac{5+2}{2}$

$\frac{6}{2}, \frac{7}{2}$

3, 3½

The carpenter should cut the board at coordinates (3, 3.5)

2.) first point 1,2      slope  $\frac{y_2 - y_1}{x_2 - x_1}$

second point 5,5       $\frac{5-2}{5-1} = \frac{3}{4}$

$y = -\frac{4}{3}x + 3\frac{1}{2}$

3½ is the y-intercept

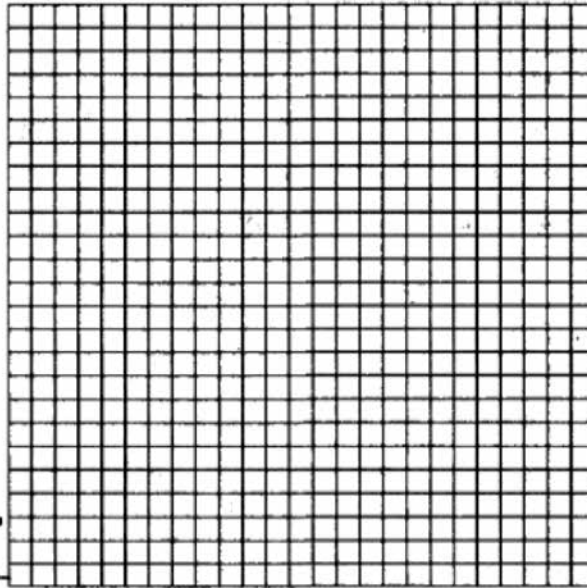
**ITEM D SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY**

**SCORE POINT: 1**

<b>Part 1</b>		<b>Points</b>
Incorrect Coordinates:	(3.5,3.5)	1
Correct Procedure with copy error:	(1,2) (6,5) [copy error: should be (1,2) (5,5)]; $\left(\frac{6+1}{2}, \frac{5+2}{2}\right)$ ; $\left(\frac{7}{2}, \frac{7}{2}\right)$	

<b>Part 2</b>		<b>Points</b>
Incorrect Equation:	$y = \frac{3}{5}x + 1.4$	0
Incorrect Procedure:	Determined the slope and equation of the original board with the incorrect coordinates.	
<b>Total Points</b>		<b>1</b>

1.)  $(x_1, y_1) (x_2, y_2)$   
 $m = \left(\frac{6+1}{2}, \frac{5+2}{2}\right)$   
 $m = \left(\frac{7}{2}, \frac{7}{2}\right)$   
 $m = (3.5, 3.5)$   
 He should cut the board at point (3.5, 3.5).



2.)  $(x_1, y_1) (x_2, y_2)$   
 Slope =  $\frac{5-2}{6-1} = \frac{3}{5}$   
 $y = mx + b$   
 $2 = \frac{3}{5}(1) + b$   
 $2 = \frac{3}{5} + b$   
 $1.4 = b$   
 $y = \frac{3}{5}x + 1.4$

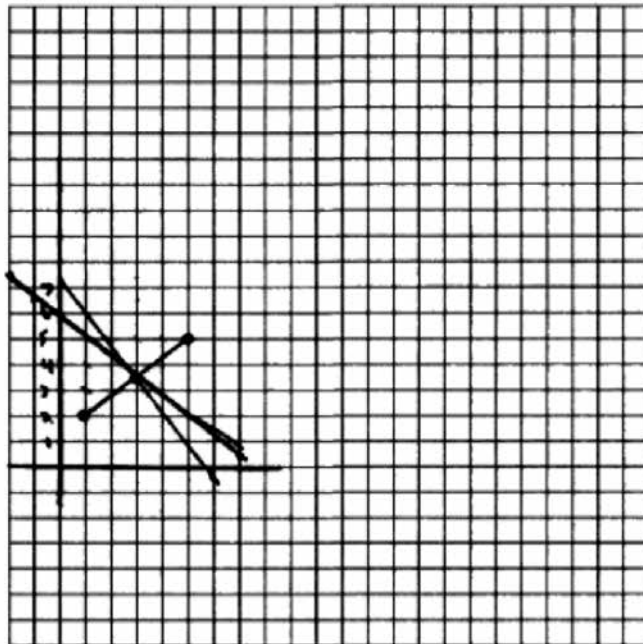
**ITEM D SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY**

**SCORE POINT: 0**

<b>Part 1</b>		<b>Points</b>
Incorrect Coordinates:	(2,1.5)	0
Incorrect Procedure:	$\left(\frac{5-1}{2}, \frac{5-2}{2}\right)$ [incorrect procedure: should be $\left(\frac{5+1}{2}, \frac{5+2}{2}\right)$ ]	
<b>Part 2</b>		<b>Points</b>
Incorrect Equation:	$x = -\frac{3}{5} + 7.5$	0
Missing Procedure:		
<b>Total Points</b>		<b>0</b>

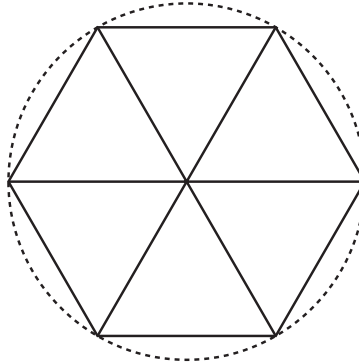
1.  $\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$   
 $(1,2) (5,5)$   
 $\left(\frac{5-1}{2}, \frac{5-2}{2}\right)$   
 $(2, 1.5)$

2.  $x = -\frac{3}{5} + 7.5$



## ITEM E—2014 GEOMETRY

- E. The pizza restaurant made a pizza in the shape of a regular hexagon for Alejandro’s party. A circular pie was cut into 6 equal slices and then the outside corner parts were removed. The pie at this restaurant is 14 inches in diameter.



1. What is the area of the circular pie? Round your answer to the nearest hundredth of a square inch. Show your work or explain how you found your answer.
2. What is the area of each triangular piece of the hexagonal pizza? Round your answer to the nearest hundredth of a square inch. Show your work or explain how you found your answer.

BE SURE TO LABEL YOUR RESPONSES 1 AND 2.

### Item E Scoring Rubric—2014 Geometry

Score	Description
4	The student earns 5 points. The response contains no incorrect work.
3	The student earns $3\frac{1}{2}$ – $4\frac{1}{2}$ points.
2	The student earns 2 – 3 points.
1	The student earns $\frac{1}{2}$ – $1\frac{1}{2}$ points, or some minimal understanding is shown.
0	The student earns 0 points. No understanding is shown.
B	Blank — No Response. A score of “B” will be reported as “NA.” (No attempt to answer the item. Score of “0” is assigned for the item.)





**ITEM E SOLUTION AND SCORING—2014 GEOMETRY**

Part	Points
2	<p><b>3 points possible:</b></p> <p>3 points: Correct area: <b>21.22 in<sup>2</sup></b> (<i>in<sup>2</sup> is not required for a 4</i>)                      Or  <b>21.21 in<sup>2</sup></b> (<i>only if the student used trigonometry</i>)                      (<i>in<sup>2</sup> is not required for a 4</i>)</p> <p>(If a label is used on a 4 paper, it must be correct.)                      Correct procedure is shown and/or explained                      Give credit for the following or equivalent:</p> <ul style="list-style-type: none"> <li>• “Each triangle is an equilateral triangle, so each angle is 60°. The altitude divides the triangle into two 30-60-90 triangles. The hypotenuse (radius) is 7, the short leg is 7, and the long leg is <math>3.5\sqrt{3}</math>.  <math display="block">A = \frac{7(3.5\sqrt{3})}{2} = 21.21762\dots \approx 21.22</math></li> <li>• <math>A_{\text{Equilateral Triangle}} = \frac{s^2\sqrt{3}}{4} = \frac{7^2\sqrt{3}}{4} = \frac{49\sqrt{3}}{4} = 21.21762\dots \approx 21.22</math></li> <li>• <math>\sin 60 = \cos 30 = \frac{x}{7} \Rightarrow x = 7 \cdot 0.86602\dots = 6.06217\dots</math>                      or  <math>\tan 60 = \frac{x}{3.5} \Rightarrow x = 3.5 \cdot 1.73205\dots = 6.06217\dots</math>                      or  <math>\tan 30 = \frac{3.5}{x} \Rightarrow x = \frac{3.5}{0.57735\dots} = 6.06217\dots</math>                      and  <math>A = \frac{bh}{2} = \frac{7 \cdot 6.06217\dots}{2} = 21.21762\dots \approx 21.22</math></li> <li>• <math>\sin 60 = \cos 30 = \frac{x}{7} \Rightarrow 6.06 = x \Rightarrow \frac{1}{2}(7)(6.06) = A \Rightarrow A \approx 21.21</math>                      (<i>only if the student used trigonometry</i>)</li> </ul> <p><b>OR</b></p> <p>2 points</p> <ul style="list-style-type: none"> <li>• Area is correctly rounded to a place other than the nearest hundredth or truncated                      Correct procedure shown and/or explained</li> </ul> <p><b>OR</b></p> <p>1½ points</p> <ul style="list-style-type: none"> <li>• Correct area                      Procedure is missing or incomplete</li> <li>• Incorrect or missing area                      Correct procedure is shown and/or explained                      Work may have a calculation, copy, or rounding error, or early rounding or truncation                      or the label exponent is attached to the numerical value.</li> </ul> <p><b>OR</b></p> <p>1 point</p> <ul style="list-style-type: none"> <li>• Correct or incorrect area due to <b>two</b> errors:                      calculation, copy, or rounding error, or early rounding or truncation                      or area is correctly rounded to a place other than the nearest hundredth                      or the label exponent is attached to the numerical value.                      Correct procedure is shown and/or explained; may be incomplete.</li> </ul>

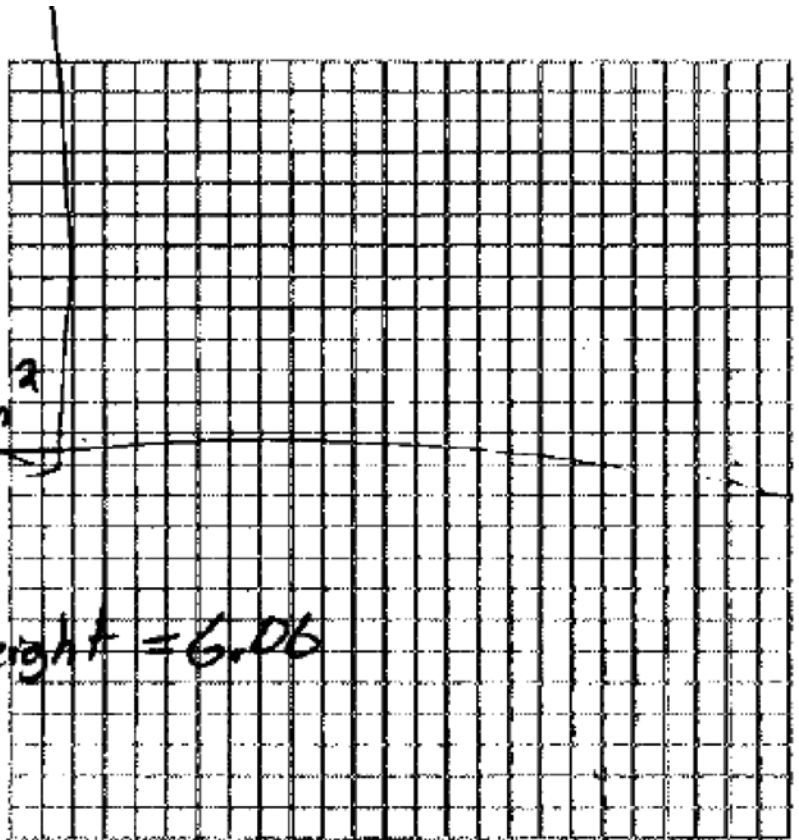
ITEM E SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 4

<u>Part 1</u>		Points
Correct Area:	153.86 in <sup>2</sup> Uses 3.14.	2
Correct Procedure:	$\pi 7^2 = 153.86$	
<u>Part 2</u>		Points
Correct Area:	21.22 in <sup>2</sup>	3
Correct Procedure:	$x^2 + 3.5^2 = 7^2$ ; $x^2 + 12.25 = 49$ ; $\sqrt{x^2} = \sqrt{36.75}$ ; $x = 6.06$ ; $\frac{7(6.06)}{2} = 21.22$	
<b>Total Points</b>		<b>5</b>

①  $A = \pi r^2$   
 $A = \pi 7^2$   
 $A = 153.86$   
 The area of the circular pie is 153.86 in<sup>2</sup>

②  $x^2 + 3.5^2 = 7^2$   
 $x^2 + 12.25 = 49$   
 $\sqrt{x^2} = \sqrt{36.75}$   
 $x = 6.06$   
 Area of triangle is  
 $A = \frac{bh}{2}$   
 $A = \frac{7(6.06)}{2}$   
 $A = 21.22$



height = 6.06

Each individual triangle has an area of 21.22 in<sup>2</sup>

ITEM E SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 3

<u>Part 1</u>		Points
Correct Area:	153.94 square inches	2
Correct Procedure:	$\pi 7^2 = 153.94$	
<u>Part 2</u>		Points
Correct Truncated Area:	21.21 square inches	2
Correct Procedure with truncation:	$\frac{7^2\sqrt{3}}{4} = 21.21$ [truncated from 21.21762...]	
<b>Total Points</b>		<b>4</b>

①  $d = 14$   
 $r = 7$

$A = \pi r^2$   
 $\pi 7^2 = 153.94$

$A = 153.94$  square inches

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②  $A = \frac{S^2\sqrt{3}}{4}$

$A = \frac{7^2\sqrt{3}}{4}$

$A = 21.21$  square inches

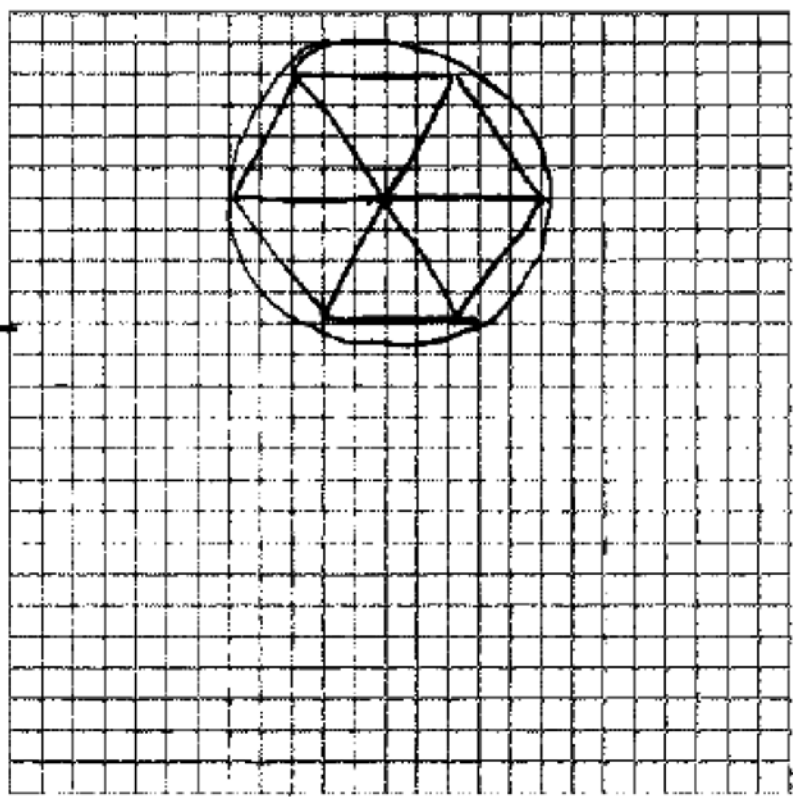
ITEM E SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 2

<b>Part 1</b>		<b>Points</b>
Correct Area:	154 in <sup>2</sup> Not rounded to the nearest hundredth.	1½
Correct Procedure:	$\pi 7^2 = 153.93804 = 154$	
<b>Part 2</b>		<b>Points</b>
Incorrect Area:	42 in <sup>2</sup>	1
Correct Procedure with <b>two</b> errors:	$\frac{7^2\sqrt{3}}{4} = 42.43524479$ [calculation error: SB 21.21762...] = 42 [Not rounded to the nearest hundredth]	
<b>Total Points</b>		<b>2½</b>

1.  $\sqrt{3.14}$   $14/2 = 7$   
 $\pi 7^2 =$   
 $\therefore 153.93804$   
 $\approx 154 \text{ in}^2$

2.  $\frac{5^2\sqrt{3}}{4}$   
 $\frac{7^2\sqrt{3}}{4}$   
 $= 42.43524479$   
 $= 42 \text{ in}^2$



ITEM E SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

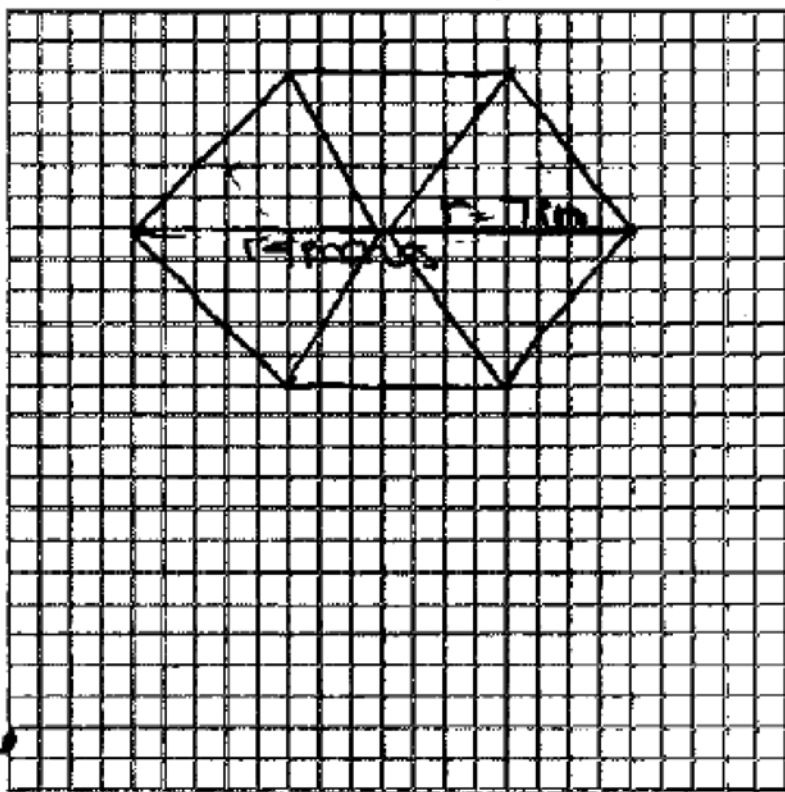
SCORE POINT: 1

<u>Part 1</u>		Points
Two Correct Areas:	153.9 or 154 Two correct answers; both not rounded to the nearest hundredth.	1½
Correct Procedure:	$\pi(7)^2 = 153.9$	
<u>Part 2</u>		Points
Two Incorrect Areas:	25.6 or 26	0
Incorrect Procedure:	154/6	
<b>Total Points</b>		<b>1½</b>

$(n-2)180^\circ$   
 $(6-2)180^\circ$   
 $4(180^\circ) = 720$

1.)  $A = \pi r^2$   
 $7^2 = 153.9$   
 or  
 $A = 154$

2.)  $\frac{A + bh}{2}$   
 $154/6 = 25.6$   
 or  
 $26$



each triangular piece equal  
25.6 or 26

ITEM E SAMPLE RESPONSES AND ANNOTATIONS—2014 GEOMETRY

SCORE POINT: 0

<u>Part 1</u>		Points
Incorrect Area:	25 inches	0
Incorrect Procedure:	$\pi 14^2$ ; 616; $\sqrt{616}$ ; 25	
<u>Part 2</u>		Points
Incorrect Area:	4 inches	0
Incorrect Procedure:	$25 \div 6 = 4$	
<b>Total Points</b>		<b>0</b>

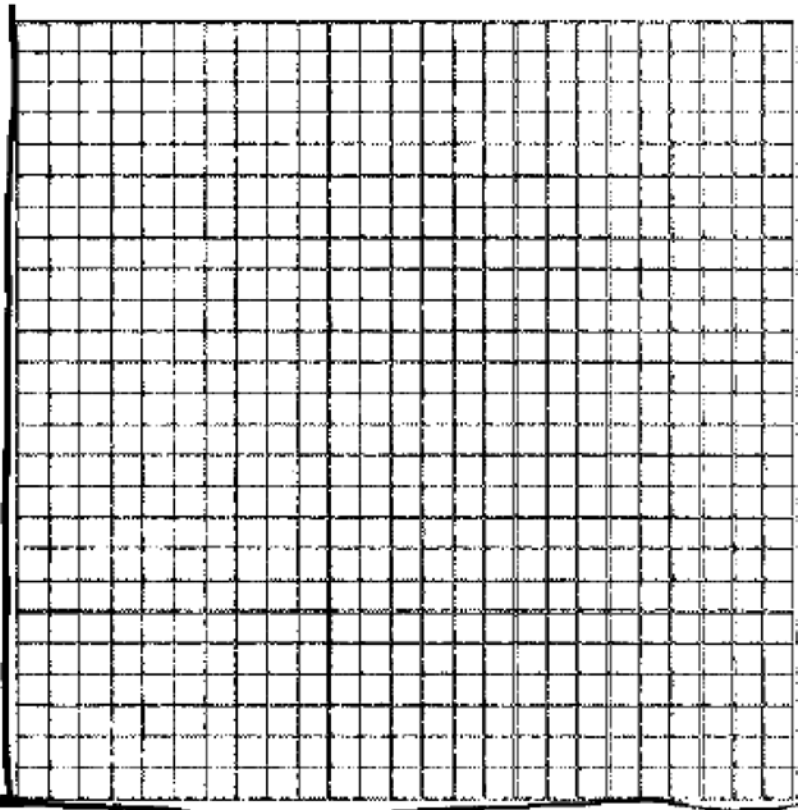
①  $A = \pi r^2$

$A = \pi 14^2$

$A = 616$  inches

$\sqrt{616}$

25 inches



②  $25 \div 6 = 4$  inches











# ACTAAP

**Arkansas Comprehensive Testing, Assessment, and Accountability Program**

**DEVELOPED FOR THE ARKANSAS DEPARTMENT OF EDUCATION, LITTLE ROCK, AR 72201**

QAI 13272-AR1404-TH-G



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