1 In the diagram below, lines $\ell$, $m$, $n$, and $p$ intersect line $r$.

Which statement is true?

(1) $\ell \parallel n$  
(2) $\ell \parallel p$  
(3) $m \parallel p$  
(4) $m \parallel n$

2 Which transformation would not always produce an image that would be congruent to the original figure?

(1) translation  
(2) dilation  
(3) rotation  
(4) reflection

3 If an equilateral triangle is continuously rotated around one of its medians, which 3-dimensional object is generated?

(1) cone  
(2) pyramid  
(3) prism  
(4) sphere
4 In the diagram below, \( \angle BDC = 100^\circ \), \( \angle A = 50^\circ \), and \( \angle DBC = 30^\circ \).

Which statement is true?

(1) \( \triangle ABD \) is obtuse.  
(2) \( \triangle ABC \) is isosceles.  
(3) \( \angle ABD = 80^\circ \).  
(4) \( \triangle ABD \) is scalene.

5 Which point shown in the graph below is the image of point \( P \) after a counterclockwise rotation of \( 90^\circ \) about the origin?

(1) \( A \)  
(2) \( B \)  
(3) \( C \)  
(4) \( D \)
6 In \( \triangle ABC \), where \( \angle C \) is a right angle, \( \cos A = \frac{\sqrt{21}}{5} \). What is \( \sin B \)?

(1) \( \frac{\sqrt{21}}{5} \) \hspace{1cm} (3) \( \frac{2}{5} \)

(2) \( \frac{\sqrt{21}}{2} \) \hspace{1cm} (4) \( \frac{5}{\sqrt{21}} \)

7 Quadrilateral \( ABCD \) with diagonals \( AC \) and \( BD \) is shown in the diagram below.

Which information is not enough to prove \( ABCD \) is a parallelogram?

(1) \( AB \parallel CD \) and \( AB \parallel DC \)
(2) \( AB \parallel CD \) and \( BC \parallel DA \)
(3) \( AB \parallel CD \) and \( BC \parallel AD \)
(4) \( AB \parallel DC \) and \( BC \parallel AD \)

8 An equilateral triangle has sides of length 20. To the nearest tenth, what is the height of the equilateral triangle?

(1) 10.0 \hspace{1cm} (3) 17.3
(2) 11.5 \hspace{1cm} (4) 23.1
9 Given: $\triangle AEC$, $\triangle DEF$, and $FE \perp CE$

What is a correct sequence of similarity transformations that shows $\triangle AEC \sim \triangle DEF$?

1. a rotation of 180 degrees about point $E$ followed by a horizontal translation
2. a counterclockwise rotation of 90 degrees about point $E$ followed by a horizontal translation
3. a rotation of 180 degrees about point $E$ followed by a dilation with a scale factor of 2 centered at point $E$
4. a counterclockwise rotation of 90 degrees about point $E$ followed by a dilation with a scale factor of 2 centered at point $E$

10 In the diagram of right triangle $ABC$, $CD$ intersects hypotenuse $AB$ at $D$.

If $AD = 4$ and $DB = 6$, which length of $AC$ makes $CD \perp AB$?

1. $2\sqrt{6}$
2. $2\sqrt{10}$
3. $2\sqrt{15}$
4. $4\sqrt{2}$
11 Segment $CD$ is the perpendicular bisector of $AB$ at $E$. Which pair of segments does not have to be congruent?

(1) $AD, BD$  (3) $AE, BE$
(2) $AC, BC$  (4) $DE, CE$

12 In triangle $CHR$, $O$ is on $HR$, and $D$ is on $CR$ so that $\angle H \cong \angle RDO$.

If $RD = 4$, $RO = 6$, and $OH = 4$, what is the length of $CD$?

(1) $\frac{2}{3}$  (3) 11
(2) $6 \frac{2}{3}$  (4) 15

13 The cross section of a regular pyramid contains the altitude of the pyramid. The shape of this cross section is a

(1) circle  (3) triangle
(2) square  (4) rectangle

14 The diagonals of rhombus $TEAM$ intersect at $P(2,1)$. If the equation of the line that contains diagonal $TA$ is $y = -x + 3$, what is the equation of a line that contains diagonal $EM$?

(1) $y = x - 1$  (3) $y = -x - 1$
(2) $y = x - 3$  (4) $y = -x - 3$
15 The coordinates of vertices $A$ and $B$ of $\triangle ABC$ are $A(3,4)$ and $B(3,12)$. If the area of $\triangle ABC$ is 24 square units, what could be the coordinates of point $C$?

(1) (3,6)  
(2) (8,−3)  
(3) (−3,8)  
(4) (6,3)

16 What are the coordinates of the center and the length of the radius of the circle represented by the equation $x^2 + y^2 − 4x + 8y + 11 = 0$?

(1) center $(2,−4)$ and radius 3  
(2) center $(-2,4)$ and radius 3  
(3) center $(2,−4)$ and radius 9  
(4) center $(-2,4)$ and radius 9

17 The density of the American white oak tree is 752 kilograms per cubic meter. If the trunk of an American white oak tree has a circumference of 4.5 meters and the height of the trunk is 8 meters, what is the approximate number of kilograms of the trunk?

(1) 13  
(2) 9694  
(3) 13,536  
(4) 30,456
18 Point $P$ is on the directed line segment from point $X(-6,-2)$ to point $Y(6,7)$ and divides the segment in the ratio 1:5. What are the coordinates of point $P$?

(1) $(4,5\frac{1}{2})$  
(2) $(-1\frac{1}{2},-4)$  
(3) $(-4\frac{1}{2},0)$  
(4) $(-4,-\frac{1}{2})$

19 In circle $O$, diameter $AB$, chord $BC$, and radius $OC$ are drawn, and the measure of arc $BC$ is $108^\circ$.

Some students wrote these formulas to find the area of sector $COB$:

Amy $\frac{3}{10} \cdot \pi \cdot (BC)^2$

Beth $\frac{108}{360} \cdot \pi \cdot (OC)^2$

Carl $\frac{3}{10} \cdot \pi \cdot \left(\frac{1}{2} AB\right)^2$

Dex $\frac{108}{360} \cdot \pi \cdot \frac{1}{2} (AB)^2$

Which students wrote correct formulas?

(1) Amy and Dex  
(2) Beth and Carl  
(3) Carl and Amy  
(4) Dex and Beth
20 Tennis balls are sold in cylindrical cans with the balls stacked one on top of the other. A tennis ball has a diameter of 6.7 cm. To the nearest cubic centimeter, what is the minimum volume of the can that holds a stack of 4 tennis balls?

(1) 236  (3) 564
(2) 282  (4) 945

21 Line segment $A'B'$, whose endpoints are $(4, -2)$ and $(16,14)$, is the image of $AB$ after a dilation of $\frac{1}{2}$ centered at the origin. What is the length of $AB$?

(1) 5  (3) 20
(2) 10  (4) 40

22 Given: $\triangle ABE$ and $\triangle CBD$ shown in the diagram below with $DB \cong BE$.

Which statement is needed to prove $\triangle ABE \cong \triangle CBD$ using only SAS $\cong$ SAS?

(1) $\angle CDB \cong \angle AEB$  (3) $AD \cong CE$
(2) $\angle AFD \cong \angle EFC$  (4) $AE \cong CD$
23 In the diagram below, \( \overline{BC} \) is the diameter of circle \( A \).

Point \( D \), which is unique from points \( B \) and \( C \), is plotted on circle \( A \). Which statement must always be true?

(1) \( \triangle BCD \) is a right triangle.
(2) \( \triangle BCD \) is an isosceles triangle.
(3) \( \triangle BAD \) and \( \triangle CBD \) are similar triangles.
(4) \( \triangle BAD \) and \( \triangle CAD \) are congruent triangles.

24 In the diagram below, \( ABCD \) is a parallelogram, \( \overline{AB} \) is extended through \( B \) to \( E \), and \( \overline{CE} \) is drawn.

If \( \overline{CE} \parallel \overline{BE} \) and \( \angle D = 112^\circ \), what is \( \angle E \)?

(1) 44°  
(2) 56°  
(3) 68°  
(4) 112°
Part II

Answer all 7 questions in this part. Each correct answer will receive 2 credits. Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc. Utilize the information provided for each question to determine your answer. Note that diagrams are not necessarily drawn to scale. For all questions in this part, a correct numerical answer with no work shown will receive only 1 credit. All answers should be written in pen, except for graphs and drawings, which should be done in pencil. [14]

25 Lines $AE$ and $BD$ are tangent to circles $O$ and $P$ at $A$, $E$, $B$, and $D$, as shown in the diagram below. If $AC:CE = 5:3$, and $BD = 56$, determine and state the length of $CD$. 

![Diagram of two circles with tangents and labeled points A, B, C, D, E, O, and P]
In the diagram below, \( \triangle ABC \) has coordinates \( A(1,1), B(4,1), \) and \( C(4,5). \) Graph and label \( \triangle A'B'C' \), the image of \( \triangle ABC \) after the translation five units to the right and two units up followed by the reflection over the line \( y = 0. \)
27 A regular hexagon is rotated in a counterclockwise direction about its center. Determine and state the minimum number of degrees in the rotation such that the hexagon will coincide with itself.
28 In the diagram of $\triangle ABC$ shown below, use a compass and straightedge to construct the median to $AB$. [Leave all construction marks.]
29 Triangle $MNP$ is the image of triangle $JKL$ after a $120^\circ$ counterclockwise rotation about point $Q$. If the measure of angle $L$ is $47^\circ$ and the measure of angle $N$ is $57^\circ$, determine the measure of angle $M$. Explain how you arrived at your answer.
A circle has a center at (1,–2) and radius of 4. Does the point (3.4,1.2) lie on the circle? Justify your answer.
31 In the diagram below, a window of a house is 15 feet above the ground. A ladder is placed against the house with its base at an angle of 75° with the ground. Determine and state the length of the ladder to the nearest tenth of a foot.
Part III

Answer all 3 questions in this part. Each correct answer will receive 4 credits. Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc. Utilize the information provided for each question to determine your answer. Note that diagrams are not necessarily drawn to scale. For all questions in this part, a correct numerical answer with no work shown will receive only 1 credit. All answers should be written in pen, except for graphs and drawings, which should be done in pencil. [12]

32 Using a compass and straightedge, construct and label $\triangle A'B'C'$, the image of $\triangle ABC$ after a dilation with a scale factor of 2 and centered at $B$. [Leave all construction marks.]

Describe the relationship between the lengths of $AC$ and $A'C'$. 

Geometry (Common Core) – Aug. '16
33 The grid below shows $\triangle ABC$ and $\triangle DEF$.

Let $\triangle A'B'C'$ be the image of $\triangle ABC$ after a rotation about point $A$. Determine and state the location of $B'$ if the location of point $C'$ is $(8,-3)$. Explain your answer.

Is $\triangle DEF$ congruent to $\triangle A'B'C'$? Explain your answer.
As modeled below, a movie is projected onto a large outdoor screen. The bottom of the 60-foot-tall screen is 12 feet off the ground. The projector sits on the ground at a horizontal distance of 75 feet from the screen.

Determine and state, to the nearest tenth of a degree, the measure of $\theta$, the projection angle.
Part IV

Answer the 2 questions in this part. Each correct answer will receive 6 credits. Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc. Utilize the information provided for each question to determine your answer. Note that diagrams are not necessarily drawn to scale. For all questions in this part, a correct numerical answer with no work shown will receive only 1 credit. All answers should be written in pen, except for graphs and drawings, which should be done in pencil. [12]

35 Given: Circle $O$, chords $AB$ and $CD$ intersect at $E$

Theorem: If two chords intersect in a circle, the product of the lengths of the segments of one chord is equal to the product of the lengths of the segments of the other chord.

Prove this theorem by proving $AE \cdot EB = CE \cdot ED$. 
36 A snow cone consists of a paper cone completely filled with shaved ice and topped with a hemisphere of shaved ice, as shown in the diagram below. The inside diameter of both the cone and the hemisphere is 8.3 centimeters. The height of the cone is 10.2 centimeters.

The desired density of the shaved ice is 0.697 g/cm$^3$, and the cost, per kilogram, of ice is $3.83. Determine and state the cost of the ice needed to make 50 snow cones.
### High School Math Reference Sheet

1 inch = 2.54 centimeters  
1 meter = 39.37 inches  
1 mile = 5280 feet  
1 mile = 1760 yards  
1 mile = 1.609 kilometers  
1 kilometer = 0.62 mile  
1 pound = 16 ounces  
1 pound = 0.454 kilogram  
1 cup = 8 fluid ounces  
1 pint = 2 cups  
1 quart = 2 pints  
1 gallon = 4 quarts  
1 gallon = 3.785 liters  
1 liter = 0.264 gallon  
1 liter = 1000 cubic centimeters

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<td>Parallelogram</td>
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<td>General Prisms</td>
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<td>Cone</td>
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<td>Pyramid</td>
<td>$V = \frac{1}{3} Bh$</td>
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### Pythagorean Theorem

$a^2 + b^2 = c^2$

### Quadratic Formula

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

### Arithmetic Sequence

$a_n = a_1 + (n - 1)d$

### Geometric Sequence

$a_n = a_1 r^{n-1}$

### Geometric Series

$S_n = \frac{a_1 - a_1 r^n}{1 - r}$ where $r \neq 1$

### Radians

1 radian = $\frac{180}{\pi}$ degrees

### Degrees

1 degree = $\frac{\pi}{180}$ radians

### Exponential Growth/Decay

$A = A_0 e^{k(t - t_0)} + B_0$
Scrap Graph Paper — This sheet will *not* be scored.
Scrap Graph Paper — This sheet will *not* be scored.
FOR TEACHERS ONLY

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

GEOMETRY (COMMON CORE)

Wednesday, August 17, 2016 — 8:30 to 11:30 a.m., only

SCORING KEY AND RATING GUIDE

Mechanics of Rating

The following procedures are to be followed for scoring student answer papers for the Regents Examination in Geometry (Common Core). More detailed information about scoring is provided in the publication Information Booklet for Scoring the Regents Examination in Geometry (Common Core).

Do not attempt to correct the student’s work by making insertions or changes of any kind. In scoring the open-ended questions, use check marks to indicate student errors. Unless otherwise specified, mathematically correct variations in the answers will be allowed. Units need not be given when the wording of the questions allows such omissions.

Each student’s answer paper is to be scored by a minimum of three mathematics teachers. No one teacher is to score more than approximately one-third of the open-ended questions on a student’s paper. Teachers may not score their own students’ answer papers. On the student’s separate answer sheet, for each question, record the number of credits earned and the teacher’s assigned rater/scorer letter.

Schools are not permitted to rescore any of the open-ended questions on this exam after each question has been rated once, regardless of the final exam score. Schools are required to ensure that the raw scores have been added correctly and that the resulting scale score has been determined accurately.

Raters should record the student’s scores for all questions and the total raw score on the student’s separate answer sheet. Then the student’s total raw score should be converted to a scale score by using the conversion chart that will be posted on the Department’s web site at: http://www.p12.nysed.gov/assessment/ on Wednesday, August 17, 2016. Because scale scores corresponding to raw scores in the conversion chart may change from one administration to another, it is crucial that, for each administration, the conversion chart provided for that administration be used to determine the student’s final score. The student’s scale score should be entered in the box provided on the student’s separate answer sheet. The scale score is the student’s final examination score.
If the student’s responses for the multiple-choice questions are being hand scored prior to being scanned, the scorer must be careful not to make any marks on the answer sheet except to record the scores in the designated score boxes. Marks elsewhere on the answer sheet will interfere with the accuracy of the scanning.

**Part I**

Allow a total of 48 credits, 2 credits for each of the following. Allow credit if the student has written the correct answer instead of the numeral 1, 2, 3, or 4.

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Updated information regarding the rating of this examination may be posted on the New York State Education Department’s web site during the rating period. Check this web site at: http://www.p12.nysed.gov/assessment/ and select the link “Scoring Information” for any recently posted information regarding this examination. This site should be checked before the rating process for this examination begins and several times throughout the Regents Examination period.

The Department is providing supplemental scoring guidance, the “Model Response Set,” for the Regents Examination in Geometry (Common Core). This guidance is intended to be part of the scorer training. Schools should use the Model Response Set along with the rubrics in the Scoring Key and Rating Guide to help guide scoring of student work. While not reflective of all scenarios, the Model Response Set illustrates how less common student responses to constructed-response questions may be scored. The Model Response Set will be available on the Department’s web site at: http://www.nysedregents.org/geometrycc/.
General Rules for Applying Mathematics Rubrics

I. General Principles for Rating

The rubrics for the constructed-response questions on the Regents Examination in Geometry (Common Core) are designed to provide a systematic, consistent method for awarding credit. The rubrics are not to be considered all-inclusive; it is impossible to anticipate all the different methods that students might use to solve a given problem. Each response must be rated carefully using the teacher's professional judgment and knowledge of mathematics; all calculations must be checked. The specific rubrics for each question must be applied consistently to all responses. In cases that are not specifically addressed in the rubrics, raters must follow the general rating guidelines in the publication Information Booklet for Scoring the Regents Examination in Geometry (Common Core), use their own professional judgment, confer with other mathematics teachers, and/or contact the State Education Department for guidance. During each Regents Examination administration period, rating questions may be referred directly to the Education Department. The contact numbers are sent to all schools before each administration period.

II. Full-Credit Responses

A full-credit response provides a complete and correct answer to all parts of the question. Sufficient work is shown to enable the rater to determine how the student arrived at the correct answer. When the rubric for the full-credit response includes one or more examples of an acceptable method for solving the question (usually introduced by the phrase “such as”), it does not mean that there are no additional acceptable methods of arriving at the correct answer. Unless otherwise specified, mathematically correct alternative solutions should be awarded credit. The only exceptions are those questions that specify the type of solution that must be used; e.g., an algebraic solution or a graphic solution. A correct solution using a method other than the one specified is awarded half the credit of a correct solution using the specified method.

III. Appropriate Work

Full-Credit Responses: The directions in the examination booklet for all the constructed-response questions state: “Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc.” The student has the responsibility of providing the correct answer and showing how that answer was obtained. The student must “construct” the response; the teacher should not have to search through a group of seemingly random calculations scribbled on the student paper to ascertain what method the student may have used.

Responses With Errors: Rubrics that state “Appropriate work is shown, but…” are intended to be used with solutions that show an essentially complete response to the question but contain certain types of errors, whether computational, rounding, graphing, or conceptual. If the response is incomplete; i.e., an equation is written but not solved or an equation is solved but not all of the parts of the question are answered, appropriate work has not been shown. Other rubrics address incomplete responses.

IV. Multiple Errors

Computational Errors, Graphing Errors, and Rounding Errors: Each of these types of errors results in a 1-credit deduction. Any combination of two of these types of errors results in a 2-credit deduction. No more than 2 credits should be deducted for such mechanical errors in a 4-credit question and no more than 3 credits should be deducted in a 6-credit question. The teacher must carefully review the student’s work to determine what errors were made and what type of errors they were.

Conceptual Errors: A conceptual error involves a more serious lack of knowledge or procedure. Examples of conceptual errors include using the incorrect formula for the area of a figure, choosing the incorrect trigonometric function, or multiplying the exponents instead of adding them when multiplying terms with exponents.

If a response shows repeated occurrences of the same conceptual error, the student should not be penalized twice. If the same conceptual error is repeated in responses to other questions, credit should be deducted in each response.

For 4- and 6-credit questions, if a response shows one conceptual error and one computational, graphing, or rounding error, the teacher must award credit that takes into account both errors. Refer to the rubric for specific scoring guidelines.
Part II

For each question, use the specific criteria to award a maximum of 2 credits. Unless otherwise specified, mathematically correct alternative solutions should be awarded appropriate credit.

(25) [2] 21, and correct work is shown.

[1] Appropriate work is shown, but one computational error is made.

or

[1] Appropriate work is shown, but one conceptual error is made.

or

[1] An appropriate equation is written to find CD, but CD is not found or is found incorrectly.

or

[1] 21, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.

(26) [2] ΔA"B"C" is graphed and labeled correctly.

[1] Appropriate work is shown, but one computational, graphing, or labeling error is made.

or

[1] Appropriate work is shown, but one conceptual error is made.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
(27)  [2] 60, and correct work is shown.

[1] Appropriate work is shown, but one computational error is made.

      or

[1] Appropriate work is shown, but one conceptual error is made.

      or

[1] 60, but no work is shown.

[0] 360, with correct or incorrect work shown, because any figure will map onto itself after a rotation of 360 about its center.

      or

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.

(28)  [2] A correct construction is drawn showing all appropriate arcs, and the median to $AB$ is drawn.

[1] A correct construction is drawn showing all appropriate arcs, but the median to $BC$ or $AC$ is drawn.

      or

[1] A correct construction is drawn showing all appropriate arcs, but the median to $AB$ is not drawn.

[0] A drawing that is not an appropriate construction is shown.

      or

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
[2] 76, and a correct explanation is written.

[1] Appropriate work is shown, but one computational error is made.

or

[1] Appropriate work is shown, but one conceptual error is made.

or

[1] Appropriate work is shown, but the explanation is missing or incorrect.

or

[1] A correct explanation is written, but the angle measure is missing or incorrect.

or

[1] 76, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.

[2] Yes, and a correct justification is shown.

[1] Appropriate work is shown, but one computational error is made.

or

[1] Appropriate work is shown, but one conceptual error is made.

or

[1] \((x - 1)^2 + (y + 2)^2 = 16\) or an equivalent equation is written, but no further correct work is shown.

[0] Yes, but no work is shown.

or

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
(31) [2] 15.5, and correct work is shown.

[1] Appropriate work is shown, but one computational or rounding error is made.

or

[1] Appropriate work is shown, but one conceptual error is made, such as using an incorrect trigonometric function.

or

[1] $\sin 75 = \frac{15}{x}$ or an equivalent equation is written, but no further correct work is shown.

or

[1] 15.5, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
Part III

For each question, use the specific criteria to award a maximum of 4 credits. Unless otherwise specified, mathematically correct alternative solutions should be awarded appropriate credit.

(32)  

[4] A correct construction is drawn showing all appropriate arcs, \( A' \) and \( C' \) are correctly labeled, and a relationship is stated such as \( 2 \cdot AC = A'C' \) or \( AC = \frac{1}{2} A'C' \).

[3] Appropriate work is shown, but one construction or labeling error is made. An appropriate geometric relationship is stated.  

\textit{or}

[3] Appropriate work is shown to construct and label the image of \( \triangle ABC \). An appropriate geometric relationship between \( \overline{AC} \) and \( \overline{A'C'} \) is stated, but it does not describe the relationship of the lengths.

[2] Appropriate work is shown, but two or more construction or labeling errors are made. An appropriate geometric relationship is stated.  

\textit{or}

[2] A correct geometric relationship is described, but no further correct work is shown.  

\textit{or}

[2] Appropriate work is shown to construct the image of \( \triangle ABC \), but no further correct work is shown.

[1] Appropriate work is shown to construct the locations of \( A' \) and \( C' \), but no further work is shown.  

\textit{or}

[1] An incomplete geometric relationship is described, but no further correct work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
(33)  

[4] (7,1), and a correct explanation is written. Yes, and a correct explanation is written.

[3] Appropriate work is shown, but one graphing error is made.

  or

[3] (7,1), but the explanation is missing, incorrect, or incomplete. Yes, and a correct explanation is written.

  or

[3] (7,1), and a correct explanation is written. Yes, but an incomplete explanation is written.

[2] Appropriate work is shown, but two or more graphing errors are made.

  or

[2] Appropriate work is shown, but one conceptual error is made.

  or

[2] (7,1), and a correct explanation is written, but no further correct work is shown.

  or

[2] (7,1), but the explanation is missing, incorrect, or incomplete. Yes, but an incomplete or incorrect explanation is written.

  or

[2] Yes, and a correct explanation is written, but no further correct work is shown.

[1] Yes, but an incomplete or incorrect explanation is written. No further correct work is shown.

  or

[1] (7,1), but no further correct work is shown.

[0] Yes, but the explanation is missing.

  or

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
34.7, and correct work is shown.

[3] Appropriate work is shown, but one computational or rounding error is made.

or

[3] Correct work is shown to find both angles of elevation, but no further correct work is shown.

[2] Appropriate work is shown, but two or more computational or rounding errors are made.

or

[2] Appropriate work is shown, but one conceptual error is made.

[1] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.

or

[1] Correct work is shown to find one angle of elevation, but no further correct work is shown.

or

[1] Two appropriate trigonometric equations are written, but no further correct work is shown.

or

[1] 34.7, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
Part IV

For each question, use the specific criteria to award a maximum of 6 credits. Unless otherwise specified, mathematically correct alternative solutions should be awarded appropriate credit.

(35)  [6] A complete and correct proof that includes a concluding statement is written.

[5] A proof is written that demonstrates a thorough understanding of the method of proof and contains no conceptual errors, but one statement and/or reason is missing or incorrect.

or

[5] A correct proportion is proven, but no further correct work is shown.

[4] A proof is written that demonstrates a good understanding of the method of proof and contains no conceptual errors, but two statements and/or reasons are missing or incorrect.

or

[4] \( \triangle ADE \sim \triangle CBE \) or \( \triangle ACE \sim \triangle DBE \) is proven, but no further correct work is shown.

[3] A proof is written that demonstrates a good understanding of the method of proof and contains no conceptual errors, but three statements and/or reasons are missing or incorrect.

or

[3] A proof is written that demonstrates a good understanding of the method of proof, but one conceptual error is made.

[2] A proof is written that demonstrates a method of proof, but one conceptual error is made, and one statement and/or reason is missing or incorrect.

or

[2] Only two correct relevant statements and reasons are written.

[1] Only one correct relevant statement and reason are written.

[0] The “given” and/or the “prove” statements are written, but no further correct relevant statements are written.

or

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
44.53, and correct work is shown.

[5] Appropriate work is shown, but one computational or rounding error is made.

or

[5] Correct work is shown to find the correct number of kilograms needed for fifty snow cones, but no further correct work is shown.

or

[5] Correct work is shown to find the cost of one snow cone, but no further correct work is shown.

[4] Appropriate work is shown, but two computational or rounding errors are made.

or

[4] Appropriate work is shown, but one conceptual error is made.

or

[4] Correct work is shown to find the correct number of grams needed for one snow cone. No further correct work is shown.

[3] Appropriate work is shown, but three or more computational or rounding errors are made.

or

[3] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.

or

[3] Correct work is shown to find the volume of fifty snow cones. No further correct work is shown.

[2] Appropriate work is shown, but one conceptual error and two computational or rounding errors are made.

or

[2] Appropriate work is shown, but two conceptual errors are made.

or

[2] Correct work is shown to find the volume of the cone and the volume of the hemisphere. No further correct work is shown.

[1] Appropriate work is shown, but one conceptual error and three or more computational or rounding errors are made.

or
[1] Appropriate work is shown, but two conceptual errors and one computational or rounding error are made.

or

[1] Correct work is shown to find the volume of the cone or the volume of the hemisphere. No further correct work is shown.

or

[1] 44.53, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
### Map to the Common Core Learning Standards
#### Geometry (Common Core)
##### August 2016

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<tr>
<td>36</td>
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<td>6</td>
<td>G-MG.A</td>
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Online Submission of Teacher Evaluations of the Test to the Department

Suggestions and feedback from teachers provide an important contribution to the test development process. The Department provides an online evaluation form for State assessments. It contains spaces for teachers to respond to several specific questions and to make suggestions. Instructions for completing the evaluation form are as follows:


2. Select the test title.

3. Complete the required demographic fields.

4. Complete each evaluation question and provide comments in the space provided.

5. Click the SUBMIT button at the bottom of the page to submit the completed form.
25 Lines $AE$ and $BD$ are tangent to circles $O$ and $P$ at $A, E, B,$ and $D,$ as shown in the diagram below. If $AC:CE = 5:3,$ and $BD = 56,$ determine and state the length of $CD.$

\[5x + 3x = 56\]
\[\frac{8x}{8} = \frac{56}{8}\]
\[x = 7\]

$CE = 3(7) = 21$

$CD = 21$

**Score 2:** The student had a complete and correct response.
Lines $AE$ and $BD$ are tangent to circles $O$ and $P$ at $A$, $E$, $B$, and $D$, as shown in the diagram below. If $AC:CE = 5:3$, and $BD = 56$, determine and state the length of $CD$.

\[ \frac{AC}{CE} = \frac{5}{3} \]
\[ BD = 56 \]
\[ CD = \frac{BD}{5/3} \]
\[ CD = \frac{56}{5/3} \]
\[ CD = 56 \times \frac{3}{5} \]
\[ CD = 33.6 \]

**Score 2:** The student had a complete and correct response.
25 Lines $AE$ and $BD$ are tangent to circles $O$ and $P$ at $A$, $E$, $B$, and $D$, as shown in the diagram below. If $AC:CE = 5:3$, and $BD = 56$, determine and state the length of $CD$.

\[
5x + 3x = 56
\]
\[
x = \frac{56}{8} = 7
\]

$CD = 35$

**Score 1:** The student substituted incorrectly and found the length of $CB$. 

**Score 2:** The student correctly set up the algebraic equation but made an error in solving for $x$. The correct value for $x$ is 7, and the length of $CD$ is 35.
Lines $AE$ and $BD$ are tangent to circles $O$ and $P$ at $A$, $E$, $B$, and $D$, as shown in the diagram below. If $AC:CE = 5:3$, and $BD = 56$, determine and state the length of $CD$.

Score 0: The student did not show enough relevant correct work to receive any credit.
In the diagram below, \( \triangle ABC \) has coordinates \( A(1,1) \), \( B(4,1) \), and \( C(4,5) \). Graph and label \( \triangle A'B'C' \), the image of \( \triangle ABC \) after the translation five units to the right and two units up followed by the reflection over the line \( y = 0 \).

Score 2: The student had a complete and correct response.
26 In the diagram below, \( \triangle ABC \) has coordinates \( A(1,1) \), \( B(4,1) \), and \( C(4,5) \). Graph and label \( \triangle A'B'C' \), the image of \( \triangle ABC \) after the translation five units to the right and two units up followed by the reflection over the line \( y = 0 \).

Score 2: The student had a complete and correct response.
26 In the diagram below, \( \triangle ABC \) has coordinates \( A(1,1) \), \( B(4,1) \), and \( C(4,5) \). Graph and label \( \triangle A''B''C'' \), the image of \( \triangle ABC \) after the translation five units to the right and two units up followed by the reflection over the line \( y = 0 \).

Score 1: The student made an error by graphing the reflection and then the translation.
In the diagram below, \( \triangle ABC \) has coordinates \( A(1,1) \), \( B(4,1) \), and \( C(4,5) \). Graph and label \( \triangle A''B''C'' \), the image of \( \triangle ABC \) after the translation five units to the right and two units up followed by the reflection over the line \( y = 0 \).

Score 1: The student made an error by translating five units to the left.
26 In the diagram below, \( \triangle ABC \) has coordinates \( A(1,1) \), \( B(4,1) \), and \( C(4,5) \). Graph and label \( \triangle A'B'C' \), the image of \( \triangle ABC \) after the translation five units to the right and two units up followed by the reflection over the line \( y = 0 \).

\[ A(1,1) \rightarrow A'(6,3) \rightarrow A''(-6,3) \]
\[ B(4,1) \rightarrow B'(9,3) \rightarrow B''(-9,3) \]
\[ C(4,5) \rightarrow C'(9,7) \rightarrow C''(-9,7) \]

**Score 1:** The student made an error by reflecting over the \( y \)-axis.
26 In the diagram below, \( \triangle ABC \) has coordinates \( A(1,1) \), \( B(4,1) \), and \( C(4,5) \). Graph and label \( \triangle A''B''C'' \), the image of \( \triangle ABC \) after the translation five units to the right and two units up followed by the reflection over the line \( y = 0 \).

\[
\begin{align*}
A(1,1) \rightarrow (6,3) \rightarrow A''(6,-3) \\
B(4,1) \rightarrow (9,3) \rightarrow B''(9,-3) \\
C(4,5) \rightarrow (9,1) \rightarrow C''(9,-7)
\end{align*}
\]

**Score 1:** The student performed the sequence of transformations algebraically.
26 In the diagram below, $\triangle ABC$ has coordinates $A(1,1)$, $B(4,1)$, and $C(4,5)$. Graph and label $\triangle A''B''C''$, the image of $\triangle ABC$ after the translation five units to the right and two units up.

**Score 0:** The student graphed the sequence of transformations incorrectly.
27 A regular hexagon is rotated in a counterclockwise direction about its center. Determine and state the minimum number of degrees in the rotation such that the hexagon will coincide with itself.

\[
\frac{180(n-2)}{n} = \frac{180(6-2)}{6}
\]

\[
\frac{120}{6} = 20
\]

\[
60^\circ
\]

**Score 2:** The student had a complete and correct response.
27 A regular hexagon is rotated in a counterclockwise direction about its center. Determine and state the minimum number of degrees in the rotation such that the hexagon will coincide with itself.

Score 2: The student had a complete and correct response.
27 A regular hexagon is rotated in a counterclockwise direction about its center. Determine and state the minimum number of degrees in the rotation such that the hexagon will coincide with itself.

**Score 2:** The student had a complete and correct response.
27 A regular hexagon is rotated in a counterclockwise direction about its center. Determine and state the minimum number of degrees in the rotation such that the hexagon will coincide with itself.

\[
\begin{align*}
180 (n-2) \\
180 (6-2) \\
180 (4) \\
\frac{720}{6} = 120^\circ
\end{align*}
\]

**Score 1:** The student found the measure of one interior angle of the hexagon.
Question 27

27 A regular hexagon is rotated in a counterclockwise direction about its center. Determine and state the minimum number of degrees in the rotation such that the hexagon will coincide with itself.

\[ n + 6 = 180 \]
\[ n + 6 = 180 \]
\[ 6 + 6 = 180 \]
\[ 12 = 180 \]
\[ x = 15 \]

Minimum number of degrees in a rotation is 15°

Score 0: The student had a completely incorrect response.
In the diagram of \( \triangle ABC \) shown below, use a compass and straightedge to construct the median to \( AB \). [Leave all construction marks.]

**Score 2:** The student had a complete and correct response.
28 In the diagram of $\triangle ABC$ shown below, use a compass and straightedge to construct the median to $AB$. [Leave all construction marks.]

Score 2: The student had a complete and correct response.
Question 28

28 In the diagram of $\triangle ABC$ shown below, use a compass and straightedge to construct the median to $AB$. [Leave all construction marks.]

Score 1: The student had a correct construction of a perpendicular bisector, but did not draw the median.
28 In the diagram of \( \triangle ABC \) shown below, use a compass and straightedge to construct the median to \( AB \). [Leave all construction marks.]

\[ \text{Score 0: } \text{The student made a drawing that was not a construction.} \]
29 Triangle $MNP$ is the image of triangle $JKL$ after a $120^\circ$ counterclockwise rotation about point $Q$. If the measure of angle $L$ is $47^\circ$ and the measure of angle $N$ is $57^\circ$, determine the measure of angle $M$. Explain how you arrived at your answer.

Score 2: The student had a complete and correct response.
29 Triangle MNP is the image of triangle JKL after a 120° counterclockwise rotation about point Q. If the measure of angle L is 47° and the measure of angle N is 57°, determine the measure of angle M. Explain how you arrived at your answer.

A rotation is an isometry, so the triangles must be congruent and have corresponding congruent angles. So that means $\angle P = \angle L$ and $\angle P = 47°$ by substitution. Then 47° and 57° can be subtracted from 180° to find $\angle M = 70°$.

Score 2: The student had a complete and correct response.
29 Triangle $MNP$ is the image of triangle $JKL$ after a $120^\circ$ counterclockwise rotation about point $Q$. If the measure of angle $L$ is $47^\circ$ and the measure of angle $N$ is $57^\circ$, determine the measure of angle $M$. Explain how you arrived at your answer.

Score 1: The student wrote a correct explanation, but the angle measure was incorrect.
Question 29

29 Triangle $MNP$ is the image of triangle $JKL$ after a $120^\circ$ counterclockwise rotation about point $Q$. If the measure of angle $L$ is $47^\circ$ and the measure of angle $N$ is $57^\circ$, determine the measure of angle $M$. Explain how you arrived at your answer.

Score 1: The student did not write an explanation.
Triangle $MNP$ is the image of triangle $JKL$ after a $120^\circ$ counterclockwise rotation about point $Q$. If the measure of angle $L$ is $47^\circ$ and the measure of angle $N$ is $57^\circ$, determine the measure of angle $M$. Explain how you arrived at your answer.

The measure of angle $M$ is $76^\circ$ because angle $J$ and angle $M$ are congruent angles.

**Score 1:** The student had an incomplete explanation.
29 Triangle $MNP$ is the image of triangle $JKL$ after a 120° counterclockwise rotation about point $Q$. If the measure of angle $L$ is 47° and the measure of angle $N$ is 57°, determine the measure of angle $M$. Explain how you arrived at your answer.

\[120 + 47 + 57 = 224°\]

\[224° - 180° = 44°\]

**Score 0:** The student had a completely incorrect response.
30 A circle has a center at (1,–2) and radius of 4. Does the point (3.4,1.2) lie on the circle? Justify your answer.

\[
(x-1)^2 + (x+2)^2 = 4^2
\]

\[
(3.4 - 1)^2 + (1.2 + 2)^2 = 16
\]

\[
5.76 + 10.24 = 16
\]

\[
16 = 16
\]

Yes

The point (3.4,1.2) lie on the circle. By using the equation of the circle, \((x-1)^2 + (x+2)^2 = 4^2\), you plug in the \(x\) and the \(y\). First you get \((3.4-1)^2 + (1.2+2)^2 = 16\). When you solve and simplify everything, you get \(16 = 16\).

**Score 2:** The student had a complete and correct response.
30 A circle has a center at $(1,-2)$ and radius of 4. Does the point $(3.4,1.2)$ lie on the circle? Justify your answer.

Yes.

\[ r = \sqrt{(3.4-1)^2 + (1.2-(-2))^2} \]
\[ r = \sqrt{5.76 + 2.24} \]
\[ r = \sqrt{8} = 4 \]
A circle has a center at \((1, -2)\) and radius of 4. Does the point \((3.4, 1.2)\) lie on the circle? Justify your answer.

\[(x+1)^2 + (y-2)^2 = 16\]
\[(3.4+1)^2 + (1.2-2)^2 = 16\]
\[19.36 + 0.64 = 16\]
\[20 \neq 16\]

**Score 1:** The student made a substitution error, but wrote an appropriate conclusion.
A circle has a center at $(1,-2)$ and radius of 4. Does the point $(3.4,1.2)$ lie on the circle? Justify your answer.

Score 0: The student had a completely incorrect response.
31 In the diagram below, a window of a house is 15 feet above the ground. A ladder is placed against the house with its base at an angle of 75° with the ground. Determine and state the length of the ladder to the nearest tenth of a foot.

Score 2: The student had a complete and correct response.
31 In the diagram below, a window of a house is 15 feet above the ground. A ladder is placed against the house with its base at an angle of 75° with the ground. Determine and state the length of the ladder to the nearest tenth of a foot.

\[ a \cdot \tan(75^\circ) = \frac{15}{a} \]

\[ a = 15 \]

\[ a^2 + b^2 = c \]

\[ \sqrt{\left(\frac{15}{\tan(75^\circ)}\right)^2 + 15^2} = c \]

\[ 15.5 = c \]

**Score 2:** The student had a complete and correct response.
31 In the diagram below, a window of a house is 15 feet above the ground. A ladder is placed against the house with its base at an angle of 75° with the ground. Determine and state the length of the ladder to the nearest tenth of a foot.

\[
\sin(75) = \frac{15}{n}
\]

\[
\quad n = 15 \cdot \sin(75)
\]

\[
\quad n = 14.5
\]

**Score 1:** The student had a correct equation, but solved it incorrectly.
31 In the diagram below, a window of a house is 15 feet above the ground. A ladder is placed against the house with its base at an angle of 75° with the ground. Determine and state the length of the ladder to the nearest tenth of a foot.

\[ a^2 + b^2 = c^2 \]
\[ (7.5)^2 + (15)^2 = c^2 \]
\[ 56.25 + 225 = c^2 \]
\[ 281.25 = c^2 \]
\[ \sqrt{281.25} = c \]
\[ 16.77050983 = c \]

Length of ladder = 16.8 ft.

Score 0: The student did not show enough relevant correct work to receive any credit.
32 Using a compass and straightedge, construct and label $\triangle A'B'C'$, the image of $\triangle ABC$ after a dilation with a scale factor of 2 and centered at $B$. [Leave all construction marks.]

Describe the relationship between the lengths of $\overline{AC}$ and $\overline{A'C'}$.

The length of $\overline{A'C'}$ is twice the length of $\overline{AC}$.

Score 4: The student had a complete and correct response.
Question 32

32 Using a compass and straightedge, construct and label \( \triangle A'B'C' \), the image of \( \triangle ABC \) after a dilation with a scale factor of 2 and centered at \( B \). [Leave all construction marks.]

Describe the relationship between the lengths of \( AC \) and \( A'C' \).

The ratio of the lengths of \( A'C' \) to \( AC \) is 2:1.

Score 4: The student had a complete and correct response.
Using a compass and straightedge, construct and label $\triangle A'B'C'$, the image of $\triangle ABC$ after a dilation with a scale factor of 2 and centered at $B$. [Leave all construction marks.]

Describe the relationship between the lengths of $\overline{AC}$ and $\overline{A'C'}$.

$\overline{AC}$ and $\overline{A'C'}$ are both parallel to each other.

**Score 3:** The student had a correct construction, but the description was of a correct relationship other than length.
32 Using a compass and straightedge, construct and label $\triangle A'B'C'$, the image of $\triangle ABC$ after a dilation with a scale factor of 2 and centered at $B$. [Leave all construction marks.]

Describe the relationship between the lengths of $\overline{AC}$ and $\overline{A'C'}$.

$\overline{AC}$ is half $\overline{A'C'}$

Score 2: The student had a correct description, but no further correct work was shown.
32 Using a compass and straightedge, construct and label $\triangle A'B'C'$, the image of $\triangle ABC$ after a dilation with a scale factor of 2 and centered at $B$. [Leave all construction marks.]

Describe the relationship between the lengths of $\overline{AC}$ and $\overline{A'C'}$.

They are in a ratio of 2:1

Score 2: The student did not label $A'$ and $C'$ on the construction. The description was incomplete.
32 Using a compass and straightedge, construct and label $\triangle A'B'C'$, the image of $\triangle ABC$ after a dilation with a scale factor of 2 and centered at $B$. [Leave all construction marks.]

Describe the relationship between the lengths of $\overline{AC}$ and $\overline{A'C'}$.

"it is doubled"

**Score 1:** The student made an incorrect construction. The description was incomplete.
32 Using a compass and straightedge, construct and label $\triangle A'B'C'$, the image of $\triangle ABC$ after a dilation with a scale factor of 2 and centered at $B$. [Leave all construction marks.]

Describe the relationship between the lengths of $AC$ and $A'C'$. 

\[ is 2x \text{ bigger}. \]

Score 1: The student wrote an incomplete description and the construction was missing.
32 Using a compass and straightedge, construct and label \( \triangle A'B'C' \), the image of \( \triangle ABC \) after a dilation with a scale factor of 2 and centered at \( B \). [Leave all construction marks.]

Describe the relationship between the lengths of \( AC \) and \( A'C' \).

\[ \overrightarrow{AC} \text{ is a dilated line segment of } \overrightarrow{AC} \]

**Score 0:** The construction and description were completely incorrect.
33 The grid below shows $\triangle ABC$ and $\triangle DEF$.

Let $\triangle A'B'C'$ be the image of $\triangle ABC$ after a rotation about point $A$. Determine and state the location of $B'$ if the location of point $C'$ is $(8,-3)$. Explain your answer.

$B'(7,1)$ The angle of rotation that took $C$ to $C'$ was 90° counter-clockwise, so take $B$ to $B'$ by finding the point using the same rotation about point $A$.

Is $\triangle DEF$ congruent to $\triangle A'B'C'$? Explain your answer.

Yes, when $\triangle A'B'C'$ is reflected over the line $x=-1$, it will map to $\triangle DEF$. Since a reflection is a rigid motion that preserves distance, $\triangle DEF \cong \triangle A'B'C'$

**Score 4:** The student had a complete and correct response.
33 The grid below shows $\triangle ABC$ and $\triangle DEF$.

Let $\triangle A'B'C'$ be the image of $\triangle ABC$ after a rotation about point $A$. Determine and state the location of $B'$ if the location of point $C'$ is $(8, -3)$. Explain your answer.

Rotate $B$ counterclockwise $90^\circ$ about $A(2, -3)$

$B(6, 8) \rightarrow (4, -5) \rightarrow (5, 4) \rightarrow (7, 1)$

$B'(7, 1)$, was found by applying the rotation algorithm from a non-origin point.

Is $\triangle DEF$ congruent to $\triangle A'B'C'$? Explain your answer. **YES**

$AC = 6$, $DF = 6$ counted

$BC = \sqrt{4^2 + 12^2} = \sqrt{16 + 144} = \sqrt{160}$

$EF = \sqrt{4^2 + 12^2} = \sqrt{16 + 144} = \sqrt{160}$

$AB = \sqrt{5^2 + 4^2} = \sqrt{25 + 16} = \sqrt{41}$

$DE = \sqrt{5^2 + 4^2} = \sqrt{25 + 16} = \sqrt{41}$

Since a rotation preserves distance, $\triangle ABC \cong \triangle A'B'C'$

So by substitution $\triangle DEF \cong \triangle A'B'C'$

**Score 4:** The student had a complete and correct response.
33 The grid below shows $\triangle ABC$ and $\triangle DEF$.

Let $\triangle A'B'C'$ be the image of $\triangle ABC$ after a rotation about point $A$. Determine and state the location of $B'$ if the location of point $C'$ is $(8, -3)$. Explain your answer.

If rotated 90° counterclockwise about $A$, so point $B'$ would be $(7, 1)$.

Is $\triangle DEF$ congruent to $\triangle A'B'C'$? Explain your answer.

$\triangle DEF$ and $\triangle A'B'C'$ are congruent by SSS so $\triangle DEF$ is congruent to $\triangle A'B'C'$ by SSS.

**Score 3:** The student wrote an incomplete explanation for why $\triangle DEF$ is congruent to $\triangle A'B'C'$. 
Let \( \triangle A'B'C' \) be the image of \( \triangle ABC \) after a rotation about point \( A \). Determine and state the location of \( B' \) if the location of point \( C' \) is \((8, -3)\). Explain your answer.

\[ B'(7, 1) \quad \text{C rotated 90°, \ so I rotated B 90°} \]

Is \( \triangle DEF \) congruent to \( \triangle A'B'C' \)? Explain your answer.

\[ \text{Yes, if you reflect } \triangle ABC \text{ over } y = -1, \text{ it matches up perfectly, so } \triangle DEF \text{ is } \cong \text{ to } \triangle A'B'C'. \]

**Score 3:** The student wrote an incomplete explanation for why \( \triangle DEF \) is congruent to \( \triangle A'B'C' \).
Question 33

33 The grid below shows \( \triangle ABC \) and \( \triangle DEF \).

Let \( \triangle A'B'C' \) be the image of \( \triangle ABC \) after a rotation about point \( A \). Determine and state the location of \( B' \) if the location of point \( C' \) is \((8, -3)\). Explain your answer.

(7, 1) \( \quad B' \) had to be the same distance away from \( C' \), as \( B \) and \( C \) were from each other.

Is \( \triangle DEF \) congruent to \( \triangle A'B'C' \)? Explain your answer.

Yes, each point is the same distance apart from one another.

Score 2: The student wrote two incomplete explanations.
33 The grid below shows $\triangle ABC$ and $\triangle DEF$.

Let $\triangle A'B'C'$ be the image of $\triangle ABC$ after a rotation about point $A$. Determine and state the location of $B'$ if the location of point $C'$ is $(8, -3)$. Explain your answer.

![Diagram of triangles A, B, C, and A', B', C']

Is $\triangle DEF$ congruent to $\triangle A'B'C'$? Explain your answer.

Score 1: The student wrote yes, but the explanation was incorrect. No further correct work was shown.
33 The grid below shows $\triangle ABC$ and $\triangle DEF$.

Let $\triangle A'B'C'$ be the image of $\triangle ABC$ after a rotation about point $A$. Determine and state the location of $B'$ if the location of point $C'$ is $(8,-3)$. Explain your answer.

Is $\triangle DEF$ congruent to $\triangle A'B'C'$? Explain your answer.

Yes

**Score 1:** The student showed work to find $(7,1)$, and wrote yes, but did not write any explanations.
33 The grid below shows \( \triangle ABC \) and \( \triangle DEF \).

Let \( \triangle A'B'C' \) be the image of \( \triangle ABC \) after a rotation about point \( A \). Determine and state the location of \( B' \) if the location of point \( C' \) is \((8,-3)\). Explain your answer.

\[
B' = (12, -14)
\]
because to get \( C \) to \( C' \) you had to +16 to the x and -6 from the y.

Is \( \triangle DEF \) congruent to \( \triangle A'B'C' \)? Explain your answer.

\[
\overline{AB} = \sqrt{(6-2)^2 + (-8+3)^2} = \sqrt{16 + 25} = \sqrt{41}
\]
\[
\overline{ED} = \sqrt{(9+4)^2 + (-1+3)^2} = \sqrt{169 + 4} = \sqrt{173}
\]

No, because not all of the sides are equal in measure.

**Score 0:** The student had a completely incorrect response.
As modeled below, a movie is projected onto a large outdoor screen. The bottom of the 60-foot-tall screen is 12 feet off the ground. The projector sits on the ground at a horizontal distance of 75 feet from the screen.

Determine and state, to the nearest tenth of a degree, the measure of $\theta$, the projection angle.

\[
\tan \theta = \frac{60}{75}
\]

\[
\theta = \tan^{-1} \left( \frac{60}{75} \right)
\]

\[
\theta = 34.7^\circ
\]

Score 4: The student had a complete and correct response.
As modeled below, a movie is projected onto a large outdoor screen. The bottom of the 60-foot-tall screen is 12 feet off the ground. The projector sits on the ground at a horizontal distance of 75 feet from the screen.

Determine and state, to the nearest tenth of a degree, the measure of $\theta$, the projection angle.

$$\theta = y - x$$

$$T = \frac{0}{A}$$

$$2\tan \frac{72}{75} = 2\tan \frac{12}{75}$$

$$\theta = 43.83 - 9.09 = 34.74$$
As modeled below, a movie is projected onto a large outdoor screen. The bottom of the 60-foot-tall screen is 12 feet off the ground. The projector sits on the ground at a horizontal distance of 75 feet from the screen.

Determine and state, to the nearest tenth of a degree, the measure of \( \theta \), the projection angle.

\[
\tan B = \frac{12}{75}
\]

\[
\tan^{-1}(\frac{12}{75}) = 35.21759297
\]

\[
\tan \theta = \frac{72}{75}
\]

\[
\tan^{-1}(\frac{72}{75}) = 48.83686067
\]

\[
48.83686067 - 35.21759297 = 3.6192677
\]

The measure of \( \theta \) is 3.6.

Score 3: The student made a transcription error.
As modeled below, a movie is projected onto a large outdoor screen. The bottom of the 60-foot-tall screen is 12 feet off the ground. The projector sits on the ground at a horizontal distance of 75 feet from the screen.

Determine and state, to the nearest tenth of a degree, the measure of $\theta$, the projection angle.

\[
75^2 + 12^2 = x^2
\]
\[
5625 + 144 = x^2
\]
\[
\sqrt{5769} \approx x
\]
\[
75.953\ldots \approx x
\]

\[
\tan(\theta) = \frac{60}{\sqrt{5769}}
\]
\[
\tan^{-1}(\tan(\theta)) = \left(\frac{60}{\sqrt{5769}}\right) \tan^{-1}
\]
\[
\theta = 38.287\ldots
\]
\[
\theta \approx 38.3
\]

**Score 2:** The student made a conceptual error in using an obtuse triangle for right triangle trigonometry.
As modeled below, a movie is projected onto a large outdoor screen. The bottom of the 60-foot-tall screen is 12 feet off the ground. The projector sits on the ground at a horizontal distance of 75 feet from the screen.

Determine and state, to the nearest tenth of a degree, the measure of $\theta$, the projection angle.

\[
\tan x = \frac{72}{75}
\]

\[
\tan x = 0.96
\]

\[
\theta = 43.8^\circ
\]

Score 1: The student determined only one angle of elevation.
As modeled below, a movie is projected onto a large outdoor screen. The bottom of the 60-foot-tall screen is 12 feet off the ground. The projector sits on the ground at a horizontal distance of 75 feet from the screen.

Determine and state, to the nearest tenth of a degree, the measure of $\theta$, the projection angle.

\[ \tan^{-1} \left( \frac{72}{75} \right) \]

43.9

**Score 0:** The student did not show enough correct work to receive any credit.
Given: Circle $O$, chords $AB$ and $CD$ intersect at $E$

Theorem: If two chords intersect in a circle, the product of the lengths of the segments of one chord is equal to the product of the lengths of the segments of the other chord.

Prove this theorem by proving $AE \cdot EB = CE \cdot ED$.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Circle $O$, chords $AB$ and $CD$ are drawn</td>
<td>1 Given</td>
</tr>
<tr>
<td>2 $\angle 1 \cong \angle 2$</td>
<td>2 Auxiliary lines can be drawn</td>
</tr>
<tr>
<td>3 $AC \cong DA$</td>
<td>3 Vertical $\angle$s are $\cong$</td>
</tr>
<tr>
<td>4 $\triangle BCE \cong \triangle DAE$</td>
<td>4 Inscribed $\angle$s that intercept the same arc are $\cong$</td>
</tr>
<tr>
<td>5 $\frac{AE}{CE} = \frac{ED}{EB}$</td>
<td>5 $AA$</td>
</tr>
<tr>
<td>6 $AE \cdot EB = CE \cdot ED$</td>
<td>6 Corresponding sides of similar $\triangle$s are proportional</td>
</tr>
<tr>
<td>7 In a proportion, the product of the means equals the product of the extremes</td>
<td></td>
</tr>
</tbody>
</table>

Score 6: The student had a complete and correct response.
35 Given: Circle O, chords $\overline{AB}$ and $\overline{CD}$ intersect at E

Theorem: If two chords intersect in a circle, the product of the lengths of the segments of one chord is equal to the product of the lengths of the segments of the other chord.

Prove this theorem by proving $AE \cdot EB = CE \cdot ED$.

<table>
<thead>
<tr>
<th>Statements</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Circle O, chords $\overline{AB}$ and $\overline{CD}$ intersect at E</td>
<td>Given</td>
</tr>
<tr>
<td>2. ( \angle CEA \cong \angle BDE ) ( \angle AED \cong \angle CEB )</td>
<td>Vertical ( \angle )'s ( \cong )</td>
</tr>
<tr>
<td>3. ( \triangle KBE \cong \triangle DAB )</td>
<td>Inscribed ( \triangle )'s that intercept the same arc are ( \cong )</td>
</tr>
<tr>
<td>4. ( \triangle ECA \sim \triangle EAD )</td>
<td>( \triangle )'s are in prop.</td>
</tr>
<tr>
<td>5. ( \frac{AE}{CE} = \frac{EB}{ED} )</td>
<td>In a proportion, product of the means is equal to the product of the extremes</td>
</tr>
</tbody>
</table>

Score 5: The student did not include drawing chords $\overline{AC}$, $\overline{CB}$, $\overline{BD}$, and $\overline{AD}$ in the proof.
35 Given: Circle $O$, chords $\overline{AB}$ and $\overline{CD}$ intersect at $E$

Theorem: If two chords intersect in a circle, the product of the lengths of the segments of one chord is equal to the product of the lengths of the segments of the other chord.

Prove this theorem by proving $AE \cdot EB = CE \cdot ED$.

Score 4: The student omitted one statement and reason, and another reason was incomplete.
35 Given: Circle $O$, chords $\overline{AB}$ and $\overline{CD}$ intersect at $E$

Theorem: If two chords intersect in a circle, the product of the lengths of the segments of one chord is equal to the product of the lengths of the segments of the other chord.

Prove this theorem by proving $AE \cdot EB = CE \cdot ED$.

<table>
<thead>
<tr>
<th>Statement</th>
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</tr>
</thead>
<tbody>
<tr>
<td>$\overline{AB}$ and $\overline{CD}$ are chords in Circle $O$, chords intersect at $E$</td>
<td>1) Given</td>
</tr>
<tr>
<td>Draw auxiliary lines $\overline{BC}$ and $\overline{AD}$</td>
<td>2) Between 2 pts there exists a line segment</td>
</tr>
<tr>
<td>$\angle C \cong \angle A$</td>
<td>3) Angles inscribed in the same arc are $\cong$</td>
</tr>
<tr>
<td>$\angle B \cong \angle D$</td>
<td>4) AA $\sim$ Thm</td>
</tr>
<tr>
<td>$\triangle BCE \cong \triangle DAE$</td>
<td>5) CPCTC</td>
</tr>
<tr>
<td>$AE \cdot EB = CE \cdot ED$</td>
<td></td>
</tr>
</tbody>
</table>

Score 3: The student had three missing or incomplete statements.
Question 35

35 Given: Circle $O$, chords $\overline{AB}$ and $\overline{CD}$ intersect at $E$

Theorem: If two chords intersect in a circle, the product of the lengths of the segments of one chord is equal to the product of the lengths of the segments of the other chord.

Prove this theorem by proving $AE \cdot EB = CE \cdot ED$.

Given circle $O$ and chords $\overline{AB}$ and $\overline{CD}$ intersect at $E$. Since vertical angles are congruent, $\angle CEB \cong \angle AED$. $\angle C$ and $\angle A$ are inscribed in $\overline{BD}$, so $\angle C \cong \angle A$. So $\triangle CEB \cong \triangle AED$. By the means extremes property, $AE \cdot EB = CE \cdot ED$.

Score 2: The student gave two correct relevant statements and reasons.
Given: Circle $O$, chords $\overline{AB}$ and $\overline{CD}$ intersect at $E$

Theorem: If two chords intersect in a circle, the product of the lengths of the segments of one chord is equal to the product of the lengths of the segments of the other chord.

Prove this theorem by proving $AE \cdot EB = CE \cdot ED$.

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>chords $\overline{AE}$ and $\overline{CD}$ intersect at $E$</td>
<td>Given</td>
</tr>
<tr>
<td>$\angle CEA \cong \angle BED$</td>
<td>Vertical angles are congruent</td>
</tr>
<tr>
<td>$\angle CEB \cong \angle AED$</td>
<td>Vertical angles are congruent</td>
</tr>
<tr>
<td>$AE \cdot EB = CE \cdot ED$</td>
<td>If two chords intersect in a circle, the product of the lengths of the segments of one chord is equal to the product of the lengths of the segments of the other chord.</td>
</tr>
</tbody>
</table>

Score 1: The student correctly stated the vertical angles were congruent.
35 Given: Circle $O$, chords $\overline{AB}$ and $\overline{CD}$ intersect at $E$

Theorem: If two chords intersect in a circle, the product of the lengths of the segments of one chord is equal to the product of the lengths of the segments of the other chord.

Prove this theorem by proving $AE \cdot EB = CE \cdot ED$.

**Score 0:** The student had a completely incorrect response.
36 A snow cone consists of a paper cone completely filled with shaved ice and topped with a hemisphere of shaved ice, as shown in the diagram below. The inside diameter of both the cone and the hemisphere is 8.3 centimeters. The height of the cone is 10.2 centimeters.

The desired density of the shaved ice is 0.697 g/cm³, and the cost, per kilogram, of ice is $3.83. Determine and state the cost of the ice needed to make 50 snow cones.

Score 6: The student had a complete and correct response.
A snow cone consists of a paper cone completely filled with shaved ice and topped with a hemisphere of shaved ice, as shown in the diagram below. The inside diameter of both the cone and the hemisphere is 8.3 centimeters. The height of the cone is 10.2 centimeters.

The desired density of the shaved ice is 0.697 g/cm$^3$, and the cost, per kilogram, of ice is $3.83. Determine and state the cost of the ice needed to make 50 snow cones.

\[
\begin{align*}
V_{\text{cone}} &= \frac{1}{3} \pi r^2 h \\
&= \frac{1}{3} \pi (4.15)^2 (10.2) \\
&= 58.5565 \pi \\
V_{\text{sphere}} &= \frac{4}{3} \pi r^3 \\
&= \frac{4}{3} \pi (4.15)^3 \\
&= 95.29783333 \pi \\
V &= 153.8543333 \pi = 483.3476433 \text{ cm}^3
\end{align*}
\]

\[
\begin{align*}
m &= \left(483.3476433 \times 1.697\right) = 336.8933074 \text{ g} \\
&= 16.846066537 \times 3.83 \\
\text{Cost} &= \$64.52
\end{align*}
\]

Score 5: The student found the volume of a sphere and not a hemisphere.
A snow cone consists of a paper cone completely filled with shaved ice and topped with a hemisphere of shaved ice, as shown in the diagram below. The inside diameter of both the cone and the hemisphere is 8.3 centimeters. The height of the cone is 10.2 centimeters.

\[ V_{\text{cone}} = \frac{1}{3} \pi r^2 h \]
\[ V = \frac{1}{3} \pi 17.2225 \cdot 10.2 \]
\[ V = 183.96 \text{ cm}^3 \]

The desired density of the shaved ice is 0.697 g/cm³, and the cost, per kilogram, of ice is $3.83. Determine and state the cost of the ice needed to make 50 snow cones.

\[ V_{\text{sphere}} = \frac{4}{3} \pi r^3 \]
\[ V = \frac{4}{3} \pi 7.1473375 \]
\[ V = 149.69 \text{ cm}^3 \]

The total volume is 333 cm³.

\[ 232.5889 \text{ grams per cone} \times 50 \]
\[ 11629.445 \text{ grams} \]
\[ \frac{11629.445}{1000} = 11.63 \text{ kilograms} \]

The cost is $441.54.

**Score 5:** The student used an incorrectly rounded total volume of one snow cone when computing the mass.
A snow cone consists of a paper cone completely filled with shaved ice and topped with a hemisphere of shaved ice, as shown in the diagram below. The inside diameter of both the cone and the hemisphere is 8.3 centimeters. The height of the cone is 10.2 centimeters.

The desired density of the shaved ice is 0.697 g/cm³, and the cost, per kilogram, of ice is $3.83. Determine and state the cost of the ice needed to make 50 snow cones.

\[ V_{cone} = \frac{1}{3} \pi r^2 h \]

\[ V_{cone} = \frac{1}{3} \pi \times 4.15^2 \times 10.2 \]

\[ V_{cone} = \frac{1}{3} \pi \times 17.2225 \times 10.2 \]

\[ V_{cone} = 183.961 \text{ cm}^3 \]

\[ 183.961 \times 0.697 = 128.221 \text{ g/cm}^3 \rightarrow 1 \text{ snow cone} \]

\[ 128.221 \times 50 = 6411.05 \]

\[ 6411.05 \times 0.00383 = 24.55 \]

The student determined the cost of the cone without the hemisphere.
A snow cone consists of a paper cone completely filled with shaved ice and topped with a hemisphere of shaved ice, as shown in the diagram below. The inside diameter of both the cone and the hemisphere is 8.3 centimeters. The height of the cone is 10.2 centimeters.

The desired density of the shaved ice is 0.697 g/cm$^3$, and the cost, per kilogram, of ice is $3.83. Determine and state the cost of the ice needed to make 50 snow cones.

\[
V_{cone} = \frac{1}{3} \cdot \frac{4}{3} \pi \cdot 4.15^2 = 149.693 \\
V_{hemisphere} = \frac{1}{3} \cdot \pi \cdot 4.15^2 \cdot 10.2 = 183.961 \\
\text{Total volume} = 333.654
\]

For 50 snow cones:

\[V_{total} = 16682.7 \text{ cm}^3\]

\[\text{kg} = \frac{16682.7}{0.697} = 23.935 \text{ kg}\]

\[\text{Cost} = 23.935 \times 3.83 = 91.67105\]

**Score 3:** The student found the volume of fifty snow cones, but no further correct work was shown.
A snow cone consists of a paper cone completely filled with shaved ice and topped with a hemisphere of shaved ice, as shown in the diagram below. The inside diameter of both the cone and the hemisphere is 8.3 centimeters. The height of the cone is 10.2 centimeters.

The desired density of the shaved ice is 0.697 g/cm³, and the cost, per kilogram, of ice is $3.83. Determine and state the cost of the ice needed to make 50 snow cones.

Score 2: The student made an error in determining the volume of the cone, but found an appropriate mass of fifty snow cones. No further correct work was shown.
A snow cone consists of a paper cone completely filled with shaved ice and topped with a hemisphere of shaved ice, as shown in the diagram below. The inside diameter of both the cone and the hemisphere is 8.3 centimeters. The height of the cone is 10.2 centimeters.

The desired density of the shaved ice is 0.697 g/cm³, and the cost, per kilogram, of ice is $3.83. Determine and state the cost of the ice needed to make 50 snow cones.

\[
\begin{align*}
0 &= \frac{m}{V} \\
0.697 \text{ g/cm}^3 &= \frac{m}{V} \\
50(3.83) &= \frac{m}{V} \\
191.5 &= \frac{m}{V} \\
191.5 &= \frac{m}{V} \\
\end{align*}
\]

\[
V = \frac{1}{3} \pi r^2 h
\]

\[
V = \frac{1}{3} \pi (4.15)^2 10.2
\]

\[
V = 183.9606702 \text{ cm}^3
\]

\[
50 \times 183.9606702 = 9198.03 \text{ cm}^3
\]

\[
\$9198.03 \text{ for 50 snow cones}
\]

**Score 1:** The student determined the volume of the cone.
36 A snow cone consists of a paper cone completely filled with shaved ice and topped with a hemisphere of shaved ice, as shown in the diagram below. The inside diameter of both the cone and the hemisphere is 8.3 centimeters. The height of the cone is 10.2 centimeters.

The desired density of the shaved ice is 0.697 g/cm³, and the cost, per kilogram, of ice is $3.83. Determine and state the cost of the ice needed to make 50 snow cones.

\[ V = \frac{1}{3} \pi r^2 h \]
\[ V = \frac{1}{3} \pi \cdot 4.15^2 \cdot 10.2 \]
\[ V = \frac{1}{3} \pi \cdot 17.22 \cdot 10.2 \]
\[ V = \frac{1}{3} \pi \cdot 175.644 \]
\[ V = 58.548 \]

**Score 0:** The student did not show enough work to receive any credit.
IMPORTANT NOTICE
Notice to Teachers

Regents Examination in Geometry (Common Core)
Wednesday, August 17, 2016, 8:30 a.m.
Question 19

This notice applies to students who are taking the August 17, 2016 Regents Examination in Geometry (Common Core).

If possible, please make the following announcement to all students taking this examination before the examination begins:

“Due to a typographical error, Question 19 does not have a correct answer choice. Please note this in your test booklet. Please darken the answer circle for choice 1 for Question 19 on your answer sheet. All students will receive credit for Question 19.”

When scoring this examination, all students should be awarded credit for Question 19.

Please photocopy this notice and provide a copy of it to each teacher administering and each teacher scoring the Regents Examination in Geometry (Common Core).

We apologize for any inconvenience this may cause, and we thank you for your hard work on behalf of the students in New York State.

**Please note that the typographical error has been corrected on the posted version of the Examination and the Scoring Key has been updated to reflect the correct answer.**
To determine the student's final examination score (scale score), find the student's total test raw score in the column labeled “Raw Score” and then locate the scale score that corresponds to that raw score. The scale score is the student's final examination score. Enter this score in the space labeled “Scale Score” on the student's answer sheet.

Schools are not permitted to rescore any of the open-ended questions on this exam after each question has been rated once, regardless of the final exam score. Schools are required to ensure that the raw scores have been added correctly and that the resulting scale score has been determined accurately.

Because scale scores corresponding to raw scores in the conversion chart change from one administration to another, it is crucial that for each administration the conversion chart provided for that administration be used to determine the student's final score. The chart above is usable only for this administration of the Regents Examination in Geometry (Common Core).