The possession or use of any communications device is strictly prohibited when taking this examination. If you have or use any communications device, no matter how briefly, your examination will be invalidated and no score will be calculated for you.
This examination has four parts, with a total of 35 questions. You must answer all questions in this examination. Record your answers to the Part I multiple-choice questions on the separate answer sheet. Write your answers to the questions in Parts II, III, and IV directly in this booklet. All work should be written in pen, except for graphs and drawings, which should be done in pencil. 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.

The formulas that you may need to answer some questions in this examination are found at the end of the examination. You may remove this sheet from this booklet.

Scrap paper is not permitted for any part of this examination, but you may use the blank spaces in this booklet as scrap paper. A sheet of scrap graph paper is provided at the end of this booklet for any question for which graphing may be helpful but is not required. You may remove this sheet from this booklet. Any work done on this sheet of scrap graph paper will not be scored.

When you have completed the examination, you must sign the statement printed at the end of the answer sheet, indicating that you had no unlawful knowledge of the questions or answers prior to the examination and that you have neither given nor received assistance in answering any of the questions during the examination. Your answer sheet cannot be accepted if you fail to sign this declaration.

Notice…
A graphing calculator, a straightedge (ruler), and a compass must be available for you to use while taking this examination.

DO NOT OPEN THIS EXAMINATION BOOKLET UNTIL THE SIGNAL IS GIVEN.
Part I

Answer all 24 questions in this part. Each correct answer will receive 2 credits. No partial credit will be allowed. Utilize the information provided for each question to determine your answer. Note that diagrams are not necessarily drawn to scale. For each statement or question, choose the word or expression that, of those given, best completes the statement or answers the question. Record your answers on your separate answer sheet. [48]

1. After a counterclockwise rotation about point X, scalene triangle ABC maps onto \( \triangle RST \), as shown in the diagram below. Which statement must be true?

   1. \( \angle A \cong \angle R \)
   2. \( \angle A \cong \angle S \)
   3. \( \overline{CB} \cong \overline{TR} \)
   4. \( \overline{CA} \cong \overline{TS} \)

Use this space for computations.
2 In the diagram below, $\overline{AB} \parallel \overline{DEF}$, $\overline{AE}$ and $\overline{BD}$ intersect at $C$, $m\angle B = 43^\circ$, and $m\angle CEF = 152^\circ$.

Which statement is true?

(1) $m\angle D = 28^\circ$  
(2) $m\angle A = 43^\circ$  
(3) $m\angle ACD = 71^\circ$  
(4) $m\angle BCE = 109^\circ$
3 In the diagram below, line \( m \) is parallel to line \( n \). Figure 2 is the image of Figure 1 after a reflection over line \( m \). Figure 3 is the image of Figure 2 after a reflection over line \( n \).

Which single transformation would carry Figure 1 onto Figure 3?

(1) a dilation  (3) a reflection
(2) a rotation  (4) a translation
4 In the diagram below, \( AF \) and \( DB \) intersect at \( C \), and \( AD \) and \( FBE \) are drawn such that \( m\angle D = 65^\circ \), \( m\angle CBE = 115^\circ \), \( DC = 7.2 \), \( AC = 9.6 \), and \( FC = 21.6 \).

![Diagram of geometric figure with labeled segments and angles]

What is the length of \( CB \)?

(1) 3.2  
(2) 4.8  
(3) 16.2  
(4) 19.2
5 Given square $RSTV$, where $RS = 9$ cm. If square $RSTV$ is dilated by a scale factor of 3 about a given center, what is the perimeter, in centimeters, of the image of $RSTV$ after the dilation?

(1) 12  (3) 36
(2) 27  (4) 108

6 In right triangle $ABC$, hypotenuse $\overline{AB}$ has a length of 26 cm, and side $\overline{BC}$ has a length of 17.6 cm. What is the measure of angle $B$, to the nearest degree?

(1) 48°  (3) 43°
(2) 47°  (4) 34°
The greenhouse pictured below can be modeled as a rectangular prism with a half-cylinder on top. The rectangular prism is 20 feet wide, 12 feet high, and 45 feet long. The half-cylinder has a diameter of 20 feet.

To the nearest cubic foot, what is the volume of the greenhouse?

(1) 17,869  (2) 24,937  (3) 39,074  (4) 67,349
8 In a right triangle, the acute angles have the relationship 
\[
\sin (2x + 4) = \cos (46).
\]

What is the value of \(x\)?

(1) 20  
(2) 21

(3) 24  
(4) 25

Use this space for computations.
9 In the diagram below, $\overline{AB} \parallel \overline{DFC}$, $\overline{EDA} \parallel \overline{CBG}$, and $\overline{EFB}$ and $\overline{AG}$ are drawn.

Which statement is always true?

(1) $\triangle DEF \equiv \triangle CBF$  
(2) $\triangle BAG \cong \triangle BAE$  
(3) $\triangle BAG \sim \triangle AEB$  
(4) $\triangle DEF \sim \triangle AEB$
10 The base of a pyramid is a rectangle with a width of 4.6 cm and a length of 9 cm. What is the height, in centimeters, of the pyramid if its volume is 82.8 cm$^3$?

(1) 6  (3) 9
(2) 2  (4) 18

11 In the diagram below of right triangle $AED$, $BC \parallel DE$.

Which statement is always true?

(1) $\frac{AC}{BC} = \frac{DE}{AE}$  (3) $\frac{AC}{CE} = \frac{BC}{DE}$
(2) $\frac{AB}{AD} = \frac{BC}{DE}$  (4) $\frac{DE}{BC} = \frac{DB}{AB}$
12 What is an equation of the line that passes through the point (6,8) and is perpendicular to a line with equation \( y = \frac{3}{2} x + 5 \)?

(1) \( y - 8 = \frac{3}{2} (x - 6) \)  
(2) \( y - 8 = -\frac{2}{3} (x - 6) \)

(3) \( y + 8 = \frac{3}{2} (x + 6) \)  
(4) \( y + 8 = -\frac{2}{3} (x + 6) \)

13 The diagram below shows parallelogram \( ABCD \) with diagonals \( \overline{AC} \) and \( \overline{BD} \) intersecting at \( E \).

What additional information is sufficient to prove that parallelogram \( ABCD \) is also a rhombus?

(1) \( \overline{BD} \) bisects \( \overline{AC} \).  
(2) \( \overline{AB} \) is parallel to \( \overline{CD} \).  
(3) \( \overline{AC} \) is congruent to \( \overline{BD} \).  
(4) \( \overline{AC} \) is perpendicular to \( \overline{BD} \).
14 Directed line segment $DE$ has endpoints $D(-4,-2)$ and $E(1,8)$. Point $F$ divides $DE$ such that $DF:FE$ is 2:3. What are the coordinates of $F$?

(1) $(-3,0)$  
(2) $(-2,2)$  
(3) $(-1,4)$  
(4) $(2,4)$
15 Triangle $DAN$ is graphed on the set of axes below. The vertices of $\triangle DAN$ have coordinates $D(-6,-1)$, $A(6,3)$, and $N(-3,10)$.

What is the area of $\triangle DAN$?

(1) $60$  
(2) $120$  
(3) $20\sqrt{13}$  
(4) $40\sqrt{13}$
16 Triangle $ABC$, with vertices at $A(0,0)$, $B(3,5)$, and $C(0,5)$, is graphed on the set of axes shown below.
Question 16 continued

Which figure is formed when \( \triangle ABC \) is rotated continuously about \( BC \)?
17 In the diagram below of circle $O$, chords $AB$ and $CD$ intersect at $E$.

If $m\overarc{AC} = 72^\circ$ and $m\angle AEC = 58^\circ$, how many degrees are in $m\overarc{DB}$?

(1) $108^\circ$  
(2) $65^\circ$  
(3) $44^\circ$  
(4) $14^\circ$
18 In triangle $SRK$ below, medians $SC$, $KE$, and $RL$ intersect at $M$.

Which statement must always be true?

(1) $3(MC) = SC$             (3) $RM = 2MC$

(2) $MC = \frac{1}{3}(SM)$     (4) $SM = KM$
19 The regular polygon below is rotated about its center.

Which angle of rotation will carry the figure onto itself?

(1) 60°  (2) 108°  (3) 216°  (4) 540°
20 What is an equation of circle $O$ shown in the graph below?

(1) $x^2 + 10x + y^2 + 4y = -13$  
(2) $x^2 - 10x + y^2 - 4y = -13$  
(3) $x^2 + 10x + y^2 + 4y = -25$  
(4) $x^2 - 10x + y^2 - 4y = -25$
21 In the diagram below of $\triangle PQR$, $ST$ is drawn parallel to $PR$, $PS = 2$, $SQ = 5$, and $TR = 5$.

What is the length of $QR$?

(1) 7  
(2) 2  
(3) $12\frac{1}{2}$  
(4) $17\frac{1}{2}$
22 The diagram below shows circle $O$ with radii $\overline{OA}$ and $\overline{OB}$. The measure of angle $AOB$ is $120^\circ$, and the length of a radius is 6 inches.

Which expression represents the length of arc $AB$, in inches?

(1) $\frac{120}{360} (6\pi)$
(2) $120(6)$
(3) $\frac{1}{3} (36\pi)$
(4) $\frac{1}{3} (12\pi)$
23 Line segment $CD$ is the altitude drawn to hypotenuse $EF$ in right triangle $ECF$. If $EC = 10$ and $EF = 24$, then, to the nearest tenth, $ED$ is

(1) 4.2  
(2) 5.4  
(3) 15.5  
(4) 21.8

24 Line $MN$ is dilated by a scale factor of 2 centered at the point (0,6). If $MN$ is represented by $y = -3x + 6$, which equation can represent $M'N'$, the image of $MN$?

(1) $y = -3x + 12$  
(2) $y = -3x + 6$  
(3) $y = -6x + 12$  
(4) $y = -6x + 6$
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 Triangle $A'B'C'$ is the image of triangle $ABC$ after a translation of 2 units to the right and 3 units up. Is triangle $ABC$ congruent to triangle $A'B'C'$? Explain why.

Work space for question 25 is continued on the next page.
Question 25 continued
26 Triangle $ABC$ and point $D(1,2)$ are graphed on the set of axes below.

Graph and label $\triangle A'B'C'$, the image of $\triangle ABC$, after a dilation of scale factor 2 centered at point $D$.

Work space for question 26 is continued on the next page.
Graph and label \( \triangle ABC \), the image of \( \triangle ABC \) after a dilation of scale factor 2 centered at point \( D \).
27 Quadrilaterals BIKE and GOLF are graphed on the set of axes below.

Describe a sequence of transformations that maps quadrilateral BIKE onto quadrilateral GOLF.
Question 27 continued

Describe a sequence of transformations that maps quadrilateral BIKE onto quadrilateral GOLF.
28 In the diagram below, secants $\overline{RST}$ and $\overline{RQP}$, drawn from point $R$, intersect circle $O$ at $S$, $T$, $Q$, and $P$.

If $RS = 6$, $ST = 4$, and $RP = 15$, what is the length of $\overline{RQ}$?

Work space for question 28 is continued on the next page.
Using a compass and straightedge, construct the median to side $\overline{AC}$ in $\triangle ABC$ below. [Leave all construction marks.]

Work space for question 29 is continued on the next page.
Question 29 continued
Skye says that the two triangles below are congruent. Margaret says that the two triangles are similar.

Question 30 is continued on the next page.
Question 30 continued

Are Skye and Margaret both correct? Explain why.
31 Randy's basketball is in the shape of a sphere with a maximum circumference of 29.5 inches. Determine and state the volume of the basketball, to the nearest cubic inch.

Work space for question 31 is continued on the next page.
Question 31 continued
Triangle $ABC$ has vertices with coordinates $A(-1,-1)$, $B(4,0)$, and $C(0,4)$. Prove that $\triangle ABC$ is an isosceles triangle but not an equilateral triangle.

[The use of the set of axes on the next page is optional.]
Question 32 continued
The map of a campground is shown below. Campsite C, first aid station F, and supply station S lie along a straight path. The path from the supply station to the tower, T, is perpendicular to the path from the supply station to the campsite. The length of path FS is 400 feet. The angle formed by path TF and path FS is 72°. The angle formed by path TC and path CS is 55°.
Determine and state, to the nearest foot, the distance from the campsite to the tower.
Shae has recently begun kickboxing and purchased training equipment as modeled in the diagram below. The total weight of the bag, pole, and unfilled base is 270 pounds. The cylindrical base is 18 inches tall with a diameter of 20 inches. The dry sand used to fill the base weighs 95.46 lbs per cubic foot.

Question 34 is continued on the next page.
Question 34 continued

To the nearest pound, determine and state the total weight of the training equipment if the base is filled to 85% of its capacity.
Part IV

Answer the question in this part. A correct answer will receive 6 credits. Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc. Utilize the information provided for the question to determine your answer. Note that diagrams are not necessarily drawn to scale. 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. [6]

35 Given: Parallelogram \(ABCD\), \(BF \perp AFD\), and \(DE \perp BEC\)

Prove: \(BEDF\) is a rectangle

Question 35 is continued on the next page.
Question 35 continued

Prove: $BEDF$ is a rectangle
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 kilogram = 2.2 pounds  
1 ton = 2000 pounds

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

Triangle

\[ A = \frac{1}{2}bh \]

Parallelogram

\[ A = bh \]

Circle

\[ A = \pi r^2 \]

Circle

\[ C = \pi d \text{ or } C = 2\pi r \]

General Prisms

\[ V = Bh \]

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

\[ a_n = a_1r^{n-1} \]

Geometric Series

\[ S_n = \frac{a_1 - a_1r^n}{1 - r} \text{ where } r \neq 1 \]

The Reference Sheet is continued on the next page.
## Reference Sheet — concluded

<table>
<thead>
<tr>
<th>Cylinder</th>
<th>$V = \pi r^2 h$</th>
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<tbody>
<tr>
<td>Sphere</td>
<td>$V = \frac{4}{3} \pi r^3$</td>
</tr>
<tr>
<td>Cone</td>
<td>$V = \frac{1}{3} \pi r^2 h$</td>
</tr>
<tr>
<td>Pyramid</td>
<td>$V = \frac{1}{3} Bh$</td>
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<tr>
<td></td>
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<tr>
<td>Radians</td>
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<tr>
<td>Degrees</td>
<td>1 degree $= \frac{\pi}{180}$ radians</td>
</tr>
<tr>
<td>Exponential Growth/Decay</td>
<td>$A = A_0 e^{k(t - t_0)} + B_0$</td>
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</tbody>
</table>
Scrap Graph Paper — This sheet will not be scored.