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.

Print your name and the name of your school on the lines above.

A separate answer sheet for Part I has been provided to you. Follow the instructions from the proctor for completing the student information on your answer sheet.

This examination has four parts, with a total of 36 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. This sheet is perforated so you may remove it 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 perforated 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.

1. In the diagram below, $\triangle ABC \equiv \triangle DEF$.

Use this space for computations.

Which sequence of transformations maps $\triangle ABC$ onto $\triangle DEF$?

(1) a reflection over the $x$-axis followed by a translation

(2) a reflection over the $y$-axis followed by a translation

(3) a rotation of 180° about the origin followed by a translation

(4) a counterclockwise rotation of 90° about the origin followed by a translation
2 On the set of axes below, the vertices of $\triangle PQR$ have coordinates $P(-6,7)$, $Q(2,1)$, and $R(-1,-3)$.

What is the area of $\triangle PQR$?

(1) 10  (3) 25
(2) 20  (4) 50

3 In right triangle $ABC$, $\angle C = 90^\circ$. If $\cos B = \frac{5}{13}$, which function also equals $\frac{5}{13}$?

(1) $\tan A$  (3) $\sin A$
(2) $\tan B$  (4) $\sin B$
4 In the diagram below, $\overarc{ABC} = 268^\circ$.

What is the number of degrees in the measure of $\angle ABC$?
(1) 134°  (3) 68°
(2) 92°    (4) 46°

5 Given $\triangle MRO$ shown below, with trapezoid $PTRO$, $MR = 9$, $MP = 2$, and $PO = 4$.

What is the length of $TR$?
(1) 4.5      (3) 3
(2) 5        (4) 6
6 A line segment is dilated by a scale factor of 2 centered at a point not on the line segment. Which statement regarding the relationship between the given line segment and its image is true?

(1) The line segments are perpendicular, and the image is one-half of the length of the given line segment.
(2) The line segments are perpendicular, and the image is twice the length of the given line segment.
(3) The line segments are parallel, and the image is twice the length of the given line segment.
(4) The line segments are parallel, and the image is one-half of the length of the given line segment.

7 Which figure always has exactly four lines of reflection that map the figure onto itself?

(1) square
(2) rectangle
(3) regular octagon
(4) equilateral triangle

8 In the diagram below of circle O, chord DF bisects chord BC at E.

If BC = 12 and FE is 5 more than DE, then FE is

(1) 13
(2) 9
(3) 6
(4) 4
9 Kelly is completing a proof based on the figure below.

She was given that \( \angle A \equiv \angle EDF \), and has already proven \( \overline{AB} \equiv \overline{DE} \). Which pair of corresponding parts and triangle congruency method would not prove \( \triangle ABC \equiv \triangle DEF \)?

- (1) \( \overline{AC} \equiv \overline{DF} \) and SAS
- (2) \( \overline{BC} \equiv \overline{EF} \) and SAS
- (3) \( \angle C \equiv \angle F \) and AAS
- (4) \( \angle CBA \equiv \angle FED \) and ASA

10 In the diagram below, \( \overline{DE} \) divides \( \overline{AB} \) and \( \overline{AC} \) proportionally, \( \angle C = 26^\circ \), \( \angle A = 82^\circ \), and \( \overline{DF} \) bisects \( \angle BDE \).

The measure of angle \( DFB \) is

- (1) 36°
- (2) 54°
- (3) 72°
- (4) 82°
11 Which set of statements would describe a parallelogram that can always be classified as a rhombus?

I. Diagonals are perpendicular bisectors of each other.
II. Diagonals bisect the angles from which they are drawn.
III. Diagonals form four congruent isosceles right triangles.

(1) I and II  (3) II and III
(2) I and III  (4) I, II, and III

12 The equation of a circle is $x^2 + y^2 - 12y + 20 = 0$. What are the coordinates of the center and the length of the radius of the circle?

(1) center (0,6) and radius 4
(2) center (0,−6) and radius 4
(3) center (0,6) and radius 16
(4) center (0,−6) and radius 16

13 In the diagram of $\triangle RST$ below, $m\angle T = 90^\circ$, $RS = 65$, and $ST = 60$.

What is the measure of $\angle S$, to the nearest degree?

(1) 23°  (3) 47°
(2) 43°  (4) 67°
14 Triangle $A'B'C'$ is the image of $\triangle ABC$ after a dilation followed by a translation.

Which statement(s) would always be true with respect to this sequence of transformations?

I. $\triangle ABC \cong \triangle A'B'C'$
II. $\triangle ABC \sim \triangle A'B'C'$
III. $AB \parallel A'B'$
IV. $AA' = BB'$

(1) II, only (3) II and III
(2) I and II (4) II, III, and IV

15 Line segment $RW$ has endpoints $R(-4,5)$ and $W(6,20)$. Point $P$ is on $RW$ such that $RP:PW$ is 2:3. What are the coordinates of point $P$?

(1) (2,9) (3) (2,14)
(2) (0,11) (4) (10,2)

16 The pyramid shown below has a square base, a height of 7, and a volume of 84.

[Diagram of a pyramid]

What is the length of the side of the base?

(1) 6 (3) 18
(2) 12 (4) 36
17 In the diagram below of triangle MNO, ∠M and ∠O are bisected by MS and OR, respectively. Segments MS and OR intersect at T, and m∠N = 40°.

![Diagram of triangle MNO with bisectors MS and OR intersecting at T.](image)

If m∠TMR = 28°, the measure of angle OTS is
(1) 40°  
(2) 50°  
(3) 60°  
(4) 70°

18 In the diagram below, right triangle ABC has legs whose lengths are 4 and 6.

![Diagram of right triangle ABC with legs 4 and 6.](image)

What is the volume of the three-dimensional object formed by continuously rotating the right triangle around AB?
(1) 32π  
(2) 48π  
(3) 96π  
(4) 144π
19 What is an equation of a line that is perpendicular to the line whose equation is $2y = 3x - 10$ and passes through $(-6, 1)$?

(1) $y = -\frac{2}{3}x - 5$  
(3) $y = \frac{2}{3}x + 1$  
(2) $y = -\frac{2}{3}x - 3$  
(4) $y = \frac{2}{3}x + 10$

20 In quadrilateral $BLUE$ shown below, $BE \equiv UL$.

Which information would be sufficient to prove quadrilateral $BLUE$ is a parallelogram?

(1) $BL \parallel EU$  
(3) $BE \equiv BL$  
(2) $LU \parallel BE$  
(4) $LU \equiv EU$

21 A ladder 20 feet long leans against a building, forming an angle of 71° with the level ground. To the nearest foot, how high up the wall of the building does the ladder touch the building?

(1) 15  
(3) 18  
(2) 16  
(4) 19

22 In the two distinct acute triangles $ABC$ and $DEF$, $\angle B \equiv \angle E$. Triangles $ABC$ and $DEF$ are congruent when there is a sequence of rigid motions that maps

(1) $\angle A$ onto $\angle D$, and $\angle C$ onto $\angle F$  
(2) $AC$ onto $DF$, and $BC$ onto $EF$  
(3) $\angle C$ onto $\angle F$, and $BC$ onto $EF$  
(4) point $A$ onto point $D$, and $AB$ onto $DE$
23 A fabricator is hired to make a 27-foot-long solid metal railing for the stairs at the local library. The railing is modeled by the diagram below. The railing is 2.5 inches high and 2.5 inches wide and is comprised of a rectangular prism and a half-cylinder.

How much metal, to the nearest cubic inch, will the railing contain?

(1) 151  
(2) 795  
(3) 1808  
(4) 2025

24 In the diagram below, \( AC = 7.2 \) and \( CE = 2.4 \).

Which statement is not sufficient to prove \( \triangle ABC \sim \triangle EDC \)?

(1) \( AB \parallel ED \)  
(2) \( DE = 2.7 \) and \( AB = 8.1 \)  
(3) \( CD = 3.6 \) and \( BC = 10.8 \)  
(4) \( DE = 3.0, AB = 9.0, CD = 2.9, \) and \( BC = 8.7 \)
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 Given: Trapezoid $JKLM$ with $JK \parallel ML$

Using a compass and straightedge, construct the altitude from vertex $J$ to $ML$.
[Leave all construction marks.]
26 Determine and state, in terms of \( \pi \), the area of a sector that intercepts a 40° arc of a circle with a radius of 4.5.
The diagram below shows two figures. Figure A is a right triangular prism and figure B is an oblique triangular prism. The base of figure A has a height of 5 and a length of 8 and the height of prism A is 14. The base of figure B has a height of 8 and a length of 5 and the height of prism B is 14.

Use Cavalieri's Principle to explain why the volumes of these two triangular prisms are equal.
28 When volleyballs are purchased, they are not fully inflated. A partially inflated volleyball can be modeled by a sphere whose volume is approximately 180 in$^3$. After being fully inflated, its volume is approximately 294 in$^3$. To the nearest tenth of an inch, how much does the radius increase when the volleyball is fully inflated?
29 In right triangle $ABC$ shown below, altitude $CD$ is drawn to hypotenuse $AB$.
Explain why $\triangle ABC \sim \triangle ACD$. 

![Diagram of right triangle ABC with altitude CD drawn to hypotenuse AB]
Triangle $ABC$ and triangle $DEF$ are drawn below.

If $AB \equiv DE$, $AC \equiv DF$, and $\angle A \equiv \angle D$, write a sequence of transformations that maps triangle $ABC$ onto triangle $DEF$. 
Line $n$ is represented by the equation $3x + 4y = 20$. Determine and state the equation of line $p$, the image of line $n$, after a dilation of scale factor $\frac{1}{3}$ centered at the point $(4,2)$. [The use of the set of axes below is optional.]

Explain your answer.
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 Triangle ABC has vertices at A(−5,2), B(−4,7), and C(−2,7), and triangle DEF has vertices at D(3,2), E(2,7), and F(0,7). Graph and label ΔABC and ΔDEF on the set of axes below.

Determine and state the single transformation where ΔDEF is the image of ΔABC.

Use your transformation to explain why ΔABC \cong ΔDEF.
33 Given: \( RS \) and \( TV \) bisect each other at point \( X \)
\( TR \) and \( SV \) are drawn

Prove: \( TR \parallel SV \)
A gas station has a cylindrical fueling tank that holds the gasoline for its pumps, as modeled below. The tank holds a maximum of 20,000 gallons of gasoline and has a length of 34.5 feet.

A metal pole is used to measure how much gas is in the tank. To the nearest tenth of a foot, how long does the pole need to be in order to reach the bottom of the tank and still extend one foot outside the tank? Justify your answer. [1 ft³ = 7.48 gallons]
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 Quadrilateral $PQRS$ has vertices $P(-2,3)$, $Q(3,8)$, $R(4,1)$, and $S(-1,-4)$.

Prove that $PQRS$ is a rhombus.
[The use of the set of axes on the next page is optional.]
Prove that \( PQRS \) is not a square.

[The use of the set of axes below is optional.]
Freda, who is training to use a radar system, detects an airplane flying at a constant speed and heading in a straight line to pass directly over her location. She sees the airplane at an angle of elevation of $15^\circ$ and notes that it is maintaining a constant altitude of 6250 feet. One minute later, she sees the airplane at an angle of elevation of $52^\circ$. How far has the airplane traveled, to the nearest foot?

Determine and state the speed of the airplane, to the nearest mile per hour.
## 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

<table>
<thead>
<tr>
<th>Geometry</th>
<th>Formula</th>
<th>Pythagorean Theorem</th>
<th>Quadratic Formula</th>
<th>Arithmetic Sequence</th>
<th>Geometric Sequence</th>
<th>Geometric Series</th>
<th>Radians</th>
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<th>Exponential Growth/Decay</th>
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</thead>
<tbody>
<tr>
<td>Triangle</td>
<td>$A = \frac{1}{2}bh$</td>
<td>$a^2 + b^2 = c^2$</td>
<td>$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$</td>
<td>$a_n = a_1 + (n - 1)d$</td>
<td>$a_n = a_1r^n - 1$</td>
<td>$S_n = \frac{a_1 - a_1r^n}{1 - r}$ where $r \neq 1$</td>
<td>$1 \text{ radian} = \frac{180}{\pi} \text{ degrees}$</td>
<td>$1 \text{ degree} = \frac{\pi}{180} \text{ radians}$</td>
<td>$A = A_0e^{k(t - t_0)} + B_0$</td>
</tr>
</tbody>
</table>
Scrap Graph Paper — This sheet will *not* be scored.