DO NOT OPEN THIS EXAMINATION BOOKLET UNTIL THE SIGNAL IS GIVEN.
1. Quadrilateral $ABCD$ undergoes a transformation, producing quadrilateral $A'B'C'D'$. For which transformation would the area of $A'B'C'D'$ not be equal to the area of $ABCD$?

(1) a rotation of $90^\circ$ about the origin
(2) a reflection over the $y$-axis
(3) a dilation by a scale factor of 2
(4) a translation defined by $(x, y) \rightarrow (x + 4, y - 1)$

2. The diameter of a sphere is 12 inches. What is the volume of the sphere to the nearest cubic inch?

(1) 288 (3) 905
(2) 452 (4) 7,238

3. A right rectangular prism is shown in the diagram below.

Which line segments are coplanar?

(1) $\overline{EF}$ and $\overline{BC}$
(2) $\overline{HD}$ and $\overline{FG}$
(3) $\overline{GH}$ and $\overline{FB}$
(4) $\overline{EA}$ and $\overline{GC}$
4 What are the coordinates of the image of point A(2,−7) under the translation \((x,y) \rightarrow (x − 3, y + 5)\)?

(1) \((-1,-2)\)  (3) \((5,-12)\)
(2) \((-1,2)\)  (4) \((5,12)\)

5 Point M is the midpoint of AB. If the coordinates of M are (2,8) and the coordinates of A are (10,12), what are the coordinates of B?

(1) \((6,10)\)  (3) \((-8,-4)\)
(2) \((-6,4)\)  (4) \((18,16)\)

6 In the diagram below, \(\overline{QM}\) is an altitude of right triangle \(PQR\), \(PM = 8\), and \(RM = 18\).

What is the length of \(\overline{QM}\)?

(1) 20  (3) 12
(2) 16  (4) 10

7 What is an equation of the line that passes through the point (2,4) and is perpendicular to the line whose equation is \(3y = 6x + 3\)?

(1) \(y = -\frac{1}{2}x + 5\)  (3) \(y = 2x - 6\)
(2) \(y = -\frac{1}{2}x + 4\)  (4) \(y = 2x\)
8 In all isosceles triangles, the exterior angle of a base angle must always be
(1) a right angle
(2) an acute angle
(3) an obtuse angle
(4) equal to the vertex angle

9 If $\triangle W'X'Y'$ is the image of $\triangle WXY$ after the transformation $R_{90^\circ}$, which statement is false?
(1) $XY = X'Y'$
(2) $WX \parallel W'X'$
(3) $\triangle WXY \cong \triangle W'X'Y'$
(4) $m\angle XWY = m\angle X'W'Y'$

10 Which equation represents the circle shown in the graph below?

- $(x - 2)^2 + y^2 = 9$
- $(x + 2)^2 + y^2 = 9$
- $(x - 2)^2 + y^2 = 3$
- $(x + 2)^2 + y^2 = 3$
11 In quadrilateral $ABCD$, each diagonal bisects opposite angles. If $m\angle DAB = 70$, then $ABCD$ must be a

(1) rectangle  
(3) rhombus

(2) trapezoid  
(4) square

12 Which diagram illustrates a correct construction of an altitude of $\triangle ABC$?

![Diagrams](image)

13 From external point $A$, two tangents to circle $O$ are drawn. The points of tangency are $B$ and $C$. Chord $BC$ is drawn to form $\triangle ABC$. If $m\angle ABC = 66$, what is $m\angle A$?

(1) 33  
(3) 57

(2) 48  
(4) 66
14 Point $A$ lies on plane $P$. How many distinct lines passing through point $A$ are perpendicular to plane $P$?

(1) 1  (3) 0
(2) 2  (4) infinite

15 Students made four statements about a circle.

A: The coordinates of its center are $(4, -3)$.
B: The coordinates of its center are $(-4, 3)$.
C: The length of its radius is $5\sqrt{2}$.
D: The length of its radius is 25.

If the equation of the circle is $(x + 4)^2 + (y - 3)^2 = 50$, which statements are correct?

(1) A and C  (3) B and C
(2) A and D  (4) B and D

16 Points $A$, $B$, $C$, and $D$ are located on circle $O$, forming trapezoid $ABCD$ with $AB \parallel DC$. Which statement must be true?

(1) $AB \equiv DC$  (3) $\angle A \equiv \angle D$
(2) $AD \equiv BC$  (4) $\widehat{AB} \equiv \widehat{DC}$

17 If $\triangle ABC \sim \triangle LMN$, which statement is not always true?

(1) $m\angle A = m\angle N$  (3) $\frac{\text{area } \triangle ABC}{\text{area } \triangle LMN} = \frac{(AC)^2}{(LN)^2}$
(2) $m\angle B = m\angle M$  (4) $\frac{\text{perimeter } \triangle ABC}{\text{perimeter } \triangle LMN} = \frac{AB}{LM}$
18 The equations representing lines $k$, $m$, and $n$ are given below.

$k: 3y + 6 = 2x$
$m: 3y + 2x + 6 = 0$
$n: 2y = 3x + 6$

Which statement is true?

(1) $k \parallel m$  
(3) $m \perp k$
(2) $n \parallel m$  
(4) $m \perp n$

19 A regular polygon with an exterior angle of $40^\circ$ is a

(1) pentagon  
(3) nonagon
(2) hexagon  
(4) decagon

20 In $\triangle ABC$ shown below, $L$ is the midpoint of $BC$, $M$ is the midpoint of $AB$, and $N$ is the midpoint of $AC$.

If $MN = 8$, $ML = 5$, and $NL = 6$, the perimeter of trapezoid $BMNC$ is

(1) 26  
(3) 30
(2) 28  
(4) 35

Use this space for computations.
21 The sum of the interior angles of a regular polygon is 720°. How many sides does the polygon have?
(1) 8  (3) 5
(2) 6  (4) 4

22 In the prism shown below, $\overline{AD} \perp \overline{AE}$ and $\overline{AD} \perp \overline{AB}$.

Which plane is perpendicular to $\overline{AD}$?
(1) $HEA$  (3) $EAB$
(2) $BAD$  (4) $EHG$

23 In $\triangle ABC$, $m\angle A = 65$ and $m\angle B$ is greater than $m\angle A$. The lengths of the sides of $\triangle ABC$ in order from smallest to largest are
(1) $AB, BC, AC$  (3) $AC, BC, AB$
(2) $BC, AB, AC$  (4) $AB, AC, BC$

24 Which equation represents a circle whose center is the origin and that passes through the point $(-4,0)$?
(1) $x^2 + y^2 = 8$  (3) $(x + 4)^2 + y^2 = 8$
(2) $x^2 + y^2 = 16$  (4) $(x + 4)^2 + y^2 = 16$
25 The lengths of two sides of a triangle are 7 and 11. Which inequality represents all possible values for $x$, the length of the third side of the triangle?

(1) $4 \leq x \leq 18$  (3) $4 \leq x < 18$
(2) $4 < x \leq 18$  (4) $4 < x < 18$

26 Which statement is the inverse of “If $x + 3 = 7$, then $x = 4$”?

(1) If $x = 4$, then $x + 3 = 7$.
(2) If $x \neq 4$, then $x + 3 \neq 7$.
(3) If $x + 3 \neq 7$, then $x \neq 4$.
(4) If $x + 3 = 7$, then $x \neq 4$.

27 In the diagram below of $\triangle MAR$, medians $\overline{MN}$, $\overline{AT}$, and $\overline{RH}$ intersect at $O$.

If $TO = 10$, what is the length of $\overline{TA}$?

(1) 30  (3) 20
(2) 25  (4) 15

28 What is an equation of the line that passes through the point (4,5) and is parallel to the line whose equation is $y = \frac{2}{3}x - 4$?

(1) $2y + 3x = 11$  (3) $3y - 2x = 2$
(2) $2y + 3x = 22$  (4) $3y - 2x = 7$
29 The measures of the angles of a triangle are in the ratio 5:6:7. Determine the measure, in degrees, of the smallest angle of the triangle.
Triangle $ABC$ has vertices $A(-1,1)$, $B(1,3)$, and $C(4,1)$. The image of $\triangle ABC$ after the transformation $r_y = x$ is $\triangle A'B'C'$. State and label the coordinates of $\triangle A'B'C'$.

[The use of the set of axes below is optional.]
31 As shown in the diagram below, a right circular cone has a height of 12 and a radius of 5.

Determine, in terms of \( \pi \), the lateral area of the right circular cone.
32 Using a compass and straightedge, locate the midpoint of $AB$ by construction. [Leave all construction marks.]
The coordinates of the endpoints of $\overline{CD}$ are $C(3,8)$ and $D(6,-1)$. Express the length of $\overline{CD}$ in simplest radical form.
34 In the diagram below, point $B$ is the incenter of $\triangle FEC$, and $EBR$, $CBD$, and $FB$ are drawn.

If $m\angle FEC = 84$ and $m\angle ECF = 28$, determine and state $m\angle BRC$. 

![Diagram of triangle with incenter B and intersection points D and R]
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. 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 Solve the following system of equations graphically. State the coordinates of all points in the solution.

\[ y + 4x = x^2 + 5 \]
\[ x + y = 5 \]
36 In parallelogram $ABCD$, with diagonal $\overline{AC}$ drawn, $\angle BCA = 4x + 2$, $\angle DAC = 6x - 6$, $\angle BAC = 5y - 1$, and $\angle DCA = 7y - 15$. Determine $\angle B$. 
37 Point $P$ is 5 units from line $j$. Sketch the locus of points that are 3 units from line $j$ and also sketch the locus of points that are 8 units from $P$. Label with an $\times$ all points that satisfy both conditions.
38 The diagram below shows square $ABCD$ where $E$ and $F$ are points on $BC$ such that $BE \cong FC$, and segments $AF$ and $DE$ are drawn.

Prove that $AF \cong DE$. 

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. A correct numerical answer with no work shown will receive only 1 credit. The answer should be written in pen, except for graphs and drawings, which should be done in pencil. [6]
## Reference Sheet

| Volume          | Cylinder | $V = Bh$
|-----------------|----------|------------------
|                 |          | where $B$ is the area of the base |
|                 | Pyramid  | $V = \frac{1}{3}Bh$
|                 |          | where $B$ is the area of the base |
|                 | Right Circular Cone | $V = \frac{1}{3}Bh$
|                 |          | where $B$ is the area of the base |
|                 | Sphere   | $V = \frac{4}{3}\pi r^3$ |

<table>
<thead>
<tr>
<th>Lateral Area ($L$)</th>
<th>Right Circular Cylinder</th>
<th>$L = 2\pi rh$</th>
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</table>
|                     | Right Circular Cone      | $L = \pi rl$
|                     |                          | where $l$ is the slant height |

<table>
<thead>
<tr>
<th>Surface Area</th>
<th>Sphere</th>
<th>$SA = 4\pi r^2$</th>
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</thead>
</table>
Scrap Graph Paper — This sheet will not be scored.