#1 Geometry – Hustle
MAΘ National Convention 2019

What is the volume of a cylinder with radius 5 and height 21?

Answer : _____

Round 1 2 3 4 5

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What is the volume of a cylinder with radius 5 and height 21?

Answer : _____

Round 1 2 3 4 5

#2 Geometry – Hustle
MAΘ National Convention 2019

The apothem of an n-gon measures 21. As n approaches infinity, what does the area of the polygon approach?

Answer : ____________________

Round 1 2 3 4 5

#2 Geometry – Hustle
MAΘ National Convention 2019

The apothem of an n-gon measures 21. As n approaches infinity, what does the area of the polygon approach?

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MAΘ National Convention 2019

The apothem of an n-gon measures 21. As n approaches infinity, what does the area of the polygon approach?

Answer : ____________________

Round 1 2 3 4 5

#3 Geometry – Hustle
MAΘ National Convention 2019

What is the maximum number of regions into which 3 planes can split up space?

Answer : _____

Round 1 2 3 4 5

#3 Geometry – Hustle
MAΘ National Convention 2019

What is the maximum number of regions into which 3 planes can split up space?

Answer : _____

Round 1 2 3 4 5

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#3 Geometry – Hustle
MAΘ National Convention 2019

What is the maximum number of regions into which 3 planes can split up space?

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Round 1 2 3 4 5

#4 Geometry – Hustle
MAΘ National Convention 2019

Points T, S, H, I lie on a circle. Chords TH and SI are perpendicular and intersect at point B. Let $TB = 3$, $IB = 2$, and $SB = 6$. Compute HB.

Answer : _____

Round 1 2 3 4 5

#4 Geometry – Hustle
MAΘ National Convention 2019

Points T, S, H, I lie on a circle. Chords TH and SI are perpendicular and intersect at point B. Let $TB = 3$, $IB = 2$, and $SB = 6$. Compute HB.

Answer : _____

Round 1 2 3 4 5

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MAΘ National Convention 2019

Points T, S, H, I lie on a circle. Chords TH and SI are perpendicular and intersect at point B. Let $TB = 3$, $IB = 2$, and $SB = 6$. Compute HB.

Answer : _____

Round 1 2 3 4 5

#4 Geometry – Hustle
MAΘ National Convention 2019

Points T, S, H, I lie on a circle. Chords TH and SI are perpendicular and intersect at point B. Let $TB = 3$, $IB = 2$, and $SB = 6$. Compute HB.

Answer : _____

Round 1 2 3 4 5

#5 Geometry – Hustle
MAΘ National Convention 2019

Let triangle KIM have side lengths $KI = 10$ and $IM = 25$, and $m\angle KIM = 150°$. What is the area of triangle KIM?

Answer : _____

Round 1 2 3 4 5

#5 Geometry – Hustle
MAΘ National Convention 2019

Let triangle KIM have side lengths $KI = 10$ and $IM = 25$, and $m\angle KIM = 150°$. What is the area of triangle KIM?

Answer : _____

Round 1 2 3 4 5

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MAΘ National Convention 2019

Let triangle KIM have side lengths $KI = 10$ and $IM = 25$, and $m\angle KIM = 150°$. What is the area of triangle KIM?

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MAΘ National Convention 2019

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Answer : _____

Round 1 2 3 4 5

#6 Geometry – Hustle
MAΘ National Convention 2019

What is the area of a triangle with vertices at coordinates $(1,1)$, $(5,6)$, and $(0,4)$?

Answer : _____

Round 1 2 3 4 5

#6 Geometry – Hustle
MAΘ National Convention 2019

What is the area of a triangle with vertices at coordinates $(1,1)$, $(5,6)$, and $(0,4)$?

Answer : _____

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Round 1 2 3 4 5

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MAΘ National Convention 2019

What is the area of a triangle with vertices at coordinates $(1,1)$, $(5,6)$, and $(0,4)$?

Answer : _____

Round 1 2 3 4 5

#7 Geometry – Hustle
MAΘ National Convention 2019

Aaron the ant is on the coordinate plane! He starts at the point $(1,2)$, and he wants to go to grad school, which is at the point $(5,5)$. In one step, Aaron can either move one unit up or one unit right (he cannot move diagonally). In how many ways can Aaron get from $(1,2)$ to $(5,5)$?

Answer : _____

Round 1 2 3 4 5

#7 Geometry – Hustle
MAΘ National Convention 2019

Aaron the ant is on the coordinate plane! He starts at the point $(1,2)$, and he wants to go to grad school, which is at the point $(5,5)$. In one step, Aaron can either move one unit up or one unit right (he cannot move diagonally). In how many ways can Aaron get from $(1,2)$ to $(5,5)$?

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Answer : _____

Round 1 2 3 4 5

#8 Geometry – Hustle
MAΘ National Convention 2019

In quadrilateral $PACK$, $PA = 4$, $AC = 10$, $CK = 7$, and $KP = 6$. If the length of diagonal PC is an integer, what is the positive difference between the maximum possible length of PC and the minimum possible length of PC?

Answer : _____

Round 1 2 3 4 5

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MAΘ National Convention 2019

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Answer : _____

Round 1 2 3 4 5

#9 Geometry – Hustle
MAΘ National Convention 2019

In triangle FAN, $FA = 4$, $AN = 7$, and $FN = x$. In interval notation, for what values of x is FAN an acute triangle?

Answer : _____

Round 1 2 3 4 5

#9 Geometry – Hustle
MAΘ National Convention 2019

In triangle FAN, $FA = 4$, $AN = 7$, and $FN = x$. In interval notation, for what values of x is FAN an acute triangle?

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MAΘ National Convention 2019

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Answer : _____

Round 1 2 3 4 5

#10 Geometry – Hustle
MAΘ National Convention 2019

Find the maximum possible area of a triangle with sides of length 5, 13, and k, where $8 < k < 18$.

Answer : _____

Round 1 2 3 4 5

#10 Geometry – Hustle
MAΘ National Convention 2019

Find the maximum possible area of a triangle with sides of length 5, 13, and k, where $8 < k < 18$.

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Find the maximum possible area of a triangle with sides of length 5, 13, and k, where $8 < k < 18$.

Answer : _____

Round 1 2 3 4 5

#11 Geometry – Hustle
MAΘ National Convention 2019

Triangle CAM has a vertex on each of the x-axis, y-axis, and z-axis. Let O be the origin $(0,0,0)$. Given that $CA = AM = \sqrt{5}$ and $CM = \sqrt{2}$, what is the volume of the tetrahedron $OCAM$?

Answer : _____

Round 1 2 3 4 5

#11 Geometry – Hustle
MAΘ National Convention 2019

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Answer : _____

Round 1 2 3 4 5

#12 Geometry – Hustle
MAΘ National Convention 2019

The diagonals of an equilateral quadrilateral measure 5 and 12. What is the area of this quadrilateral?

Answer : ______________________

Round 1 2 3 4 5

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MAΘ National Convention 2019

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Round 1 2 3 4 5

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Round 1 2 3 4 5

#12 Geometry – Hustle
MAΘ National Convention 2019

The diagonals of an equilateral quadrilateral measure 5 and 12. What is the area of this quadrilateral?

Answer : ______________________

Round 1 2 3 4 5

#13 Geometry – Hustle
MAΘ National Convention 2019

In triangle SUN, $SN = 2\sqrt{3}$ and $SU = 4$. UN is of length 2 with probability $1/2$ and $2\sqrt{3}$ with probability $1/2$. Compute the expected value of the area of SUN.

Answer : _____

Round 1 2 3 4 5

#13 Geometry – Hustle
MAΘ National Convention 2019

In triangle SUN, $SN = 2\sqrt{3}$ and $SU = 4$. UN is of length 2 with probability $1/2$ and $2\sqrt{3}$ with probability $1/2$. Compute the expected value of the area of SUN.

Answer : _____

Round 1 2 3 4 5

#13 Geometry – Hustle
MAΘ National Convention 2019

In triangle SUN, $SN = 2\sqrt{3}$ and $SU = 4$. UN is of length 2 with probability $1/2$ and $2\sqrt{3}$ with probability $1/2$. Compute the expected value of the area of SUN.

Answer : _____

Round 1 2 3 4 5

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MAΘ National Convention 2019

In triangle SUN, $SN = 2\sqrt{3}$ and $SU = 4$. UN is of length 2 with probability $1/2$ and $2\sqrt{3}$ with probability $1/2$. Compute the expected value of the area of SUN.

Answer : _____

Round 1 2 3 4 5

#14 Geometry – Hustle
MAΘ National Convention 2019

A circle with center I has radius 4. Point H lies on the circle and point S lies on the ray IH so that $IS = 7$. A line passing through S intersects the circle at points N and E. Compute the maximum possible area of triangle INE.

Answer : _____

Round 1 2 3 4 5

#14 Geometry – Hustle
MAΘ National Convention 2019

A circle with center I has radius 4. Point H lies on the circle and point S lies on the ray IH so that $IS = 7$. A line passing through S intersects the circle at points N and E. Compute the maximum possible area of triangle INE.

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Round 1 2 3 4 5

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Answer : _____

Round 1 2 3 4 5

#15 Geometry – Hustle
MAΘ National Convention 2019

Let the *romi ratio* of a right triangle be the ratio of the length of its hypotenuse squared to its area. For right triangles with positive leg lengths, what is the minimum value of the romi ratio?

Answer : ______________________

Round 1 2 3 4 5

#15 Geometry – Hustle
MAΘ National Convention 2019

Let the *romi ratio* of a right triangle be the ratio of the length of its hypotenuse squared to its area. For right triangles with positive leg lengths, what is the minimum value of the romi ratio?

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Round 1 2 3 4 5

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Answer : ______________________

Round 1 2 3 4 5

#16 Geometry – Hustle
MAΘ National Convention 2019

Apollonius's identity states that for triangle ABC, with D the midpoint of side BC,
$AB^2 + AC^2 = \frac{1}{2}BC^2 + 2AD^2$.

Utilizing this useful fact, let KIM be a triangle such that $KI = 7$, $IM = 8$, and $KM = 9$. Let N be the midpoint of side IM. Compute the length of the cevian KN.

Answer : _____

Round 1 2 3 4 5

#16 Geometry – Hustle
MAΘ National Convention 2019

Apollonius's identity states that for triangle ABC, with D the midpoint of side BC,
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Answer : _____

Round 1 2 3 4 5

#17 Geometry – Hustle
MAΘ National Convention 2019

In triangle STY, R lies on segment TY so that $RT = RY$. Given that O is the midpoint of segment SR, what is the ratio of the area of triangle ROT to the area of triangle STY?

Answer : _____

Round 1 2 3 4 5

#17 Geometry – Hustle
MAΘ National Convention 2019

In triangle STY, R lies on segment TY so that $RT = RY$. Given that O is the midpoint of segment SR, what is the ratio of the area of triangle ROT to the area of triangle STY?

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Round 1 2 3 4 5

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Answer : _____

Round 1 2 3 4 5

#18 Geometry – Hustle
MAΘ National Convention 2019

In cyclic quadrilateral $KONG$, $KO = 2$, $ON = 9$, and $NG = 6$. Given that KN is the diameter of $KONG$'s circumscribed circle, compute the length of KG.

Answer : _____

Round 1 2 3 4 5

#18 Geometry – Hustle
MAΘ National Convention 2019

In cyclic quadrilateral $KONG$, $KO = 2$, $ON = 9$, and $NG = 6$. Given that KN is the diameter of $KONG$'s circumscribed circle, compute the length of KG.

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Round 1 2 3 4 5

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Answer : _____

Round 1 2 3 4 5

#19 Geometry – Hustle
MAΘ National Convention 2019

Square $STEF$ has side length 4. A semicircle with diameter SF is constructed inside the square. The tangent to the semicircle from E that is not parallel to ST intersects side ST at V. Compute the length of segment EV.

Answer : _____

Round 1 2 3 4 5

#19 Geometry – Hustle
MAΘ National Convention 2019

Square $STEF$ has side length 4. A semicircle with diameter SF is constructed inside the square. The tangent to the semicircle from E that is not parallel to ST intersects side ST at V. Compute the length of segment EV.

Answer : _____

Round 1 2 3 4 5

#19 Geometry – Hustle
MAΘ National Convention 2019

Square $STEF$ has side length 4. A semicircle with diameter SF is constructed inside the square. The tangent to the semicircle from E that is not parallel to ST intersects side ST at V. Compute the length of segment EV.

Answer : _____

Round 1 2 3 4 5

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MAΘ National Convention 2019

Square $STEF$ has side length 4. A semicircle with diameter SF is constructed inside the square. The tangent to the semicircle from E that is not parallel to ST intersects side ST at V. Compute the length of segment EV.

Answer : _____

Round 1 2 3 4 5

#20 Geometry – Hustle
MAΘ National Convention 2019

In rectangle $HASE$, $HA = 6$ and $AS = 12$. Let SE be extended 2 units past E to point U, and let M be the intersection of segments UA and EH. Compute the area of triangle HAM.

Answer : _____

Round 1 2 3 4 5

#20 Geometry – Hustle
MAΘ National Convention 2019

In rectangle $HASE$, $HA = 6$ and $AS = 12$. Let SE be extended 2 units past E to point U, and let M be the intersection of segments UA and EH. Compute the area of triangle HAM.

Answer : _____

Round 1 2 3 4 5

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MAΘ National Convention 2019

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Answer : _____

Round 1 2 3 4 5

#21 Geometry – Hustle
MAΘ National Convention 2019

How many of the following constructions are always possible with a straightedge and a compass?

i. Constructing a square with the same area as a given circle.
ii. Bisecting an angle.
iii. Trisecting an angle.
iv. Constructing a 30° angle.
v. Constructing the center of a given circle.

Answer : _____

Round 1 2 3 4 5

#21 Geometry – Hustle
MAΘ National Convention 2019

How many of the following constructions are always possible with a straightedge and a compass?

i. Constructing a square with the same area as a given circle.
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Answer : _____

Round 1 2 3 4 5

#21 Geometry – Hustle
MAΘ National Convention 2019

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iv. Constructing a 30° angle.
v. Constructing the center of a given circle.

Answer : _____

Round 1 2 3 4 5

#22 Geometry – Hustle
MAΘ National Convention 2019

In logic, when one says $X \Leftrightarrow Y$ is true, which of the following statements must also be true?

a. $X \rightarrow Y$
b. The contrapositive of $X \rightarrow Y$
c. The converse of $X \rightarrow Y$
d. The inverse of $X \rightarrow Y$

(Write the letters of all the true statements in **alphabetical** order. For example, if only a. and b. must be true, write ab.)

Answer : _____

Round 1 2 3 4 5

#22 Geometry – Hustle
MAΘ National Convention 2019

In logic, when one says $X \Leftrightarrow Y$ is true, which of the following statements must also be true?

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Answer : _____

Round 1 2 3 4 5

#23 Geometry – Hustle
MAΘ National Convention 2019

A certain type of proof that often appears in geometry and other branches of mathematics shows the existence of a mathematical object (such as a number or a point) that satisfies given conditions by either explicitly creating or giving a way to create such an object. This type of proof is often referred to as a proof by _____. Fill in the blank.

Answer : _____

Round 1 2 3 4 5

#23 Geometry – Hustle
MAΘ National Convention 2019

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Round 1 2 3 4 5

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Answer : _____

Round 1 2 3 4 5

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Answer : _____

Round 1 2 3 4 5

#24 Geometry – Hustle
MAΘ National Convention 2019

How many of the following quadrilaterals must be cyclic?

i. Square
ii. Rectangle
iii. Isosceles Trapezoid
iv. Equiangular Rhombus
v. Kite

Answer : _____

Round 1 2 3 4 5

#24 Geometry – Hustle
MAΘ National Convention 2019

How many of the following quadrilaterals must be cyclic?

i. Square
ii. Rectangle
iii. Isosceles Trapezoid
iv. Equiangular Rhombus
v. Kite

Answer : _____

Round 1 2 3 4 5

#24 Geometry – Hustle
MAΘ National Convention 2019

How many of the following quadrilaterals must be cyclic?

i. Square
ii. Rectangle
iii. Isosceles Trapezoid
iv. Equiangular Rhombus
v. Kite

Answer : _____

Round 1 2 3 4 5

#24 Geometry – Hustle
MAΘ National Convention 2019

How many of the following quadrilaterals must be cyclic?

i. Square
ii. Rectangle
iii. Isosceles Trapezoid
iv. Equiangular Rhombus
v. Kite

Answer : _____

Round 1 2 3 4 5

#25 Geometry – Hustle
MAΘ National Convention 2019

Let $STORY$ be a cyclic pentagon such that $ST = TO = OR = 5$, $RY = 6$, and $YS = 8$. Let X be the center of the circumscribed circle of $STORY$. Given that $\tan \angle SRY = \frac{4}{3}$, compute the length of segment TX.

Answer : _____

Round 1 2 3 4 5

#25 Geometry – Hustle
MAΘ National Convention 2019

Let $STORY$ be a cyclic pentagon such that $ST = TO = OR = 5$, $RY = 6$, and $YS = 8$. Let X be the center of the circumscribed circle of $STORY$. Given that $\tan \angle SRY = \frac{4}{3}$, compute the length of segment TX.

Answer : _____

Round 1 2 3 4 5

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