Question #0 Theta Bowl
MAΘ National Convention 2025

Answer the following questions based on the function $f(x) = x^3 + 3x^2 - 9x - 15$.

The function has a relative maximum at $x = -3$. Let $A = f(-3)$.

The function has a relative minimum at $x = 1$. Let $B = f(1)$.

The function has a point of inflection at $x = -1$. Let $C = f(-1)$.

Let $D =$ the coefficient of the linear term.

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Question #1 Theta Bowl
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Answer the following questions based on the function $f(x)=\dfrac{1+2x-x^2-2x^3}{(x-2)^2}$.

Let $(a,0),(b,0),(c,0),$ and $(0,d)$ be the intercepts of the given function. Let $A=a+b+c+d$.

Let $y=gx+h$ be the slant asymptote of the function. Let $B=|g\cdot h|$.

The slant asymptote intersects the graph of f at (m,n). Let $C=m+n,$ written as an improper fraction.

Let $D=$ the interval(s) where $f(x)>0,$ using interval notation and improper fractions (as needed).

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Question #2 Theta Bowl
MAΘ National Convention 2025

Let $f(x)=3x-1$, where $x\geq 1$, and $g(x)=x^2+1$, where $x\leq 5$. Let $A=$ the domain of $f\circ g$, written in interval notation.

$h(x)=\dfrac{4}{2-x}$. Let $B=h^{-1}\left(\dfrac{1}{5}\right)$.

Suppose the function k satisfies $k(3)=5$ and $k(x)=k(x-1)-2x$. Let $C=k(1)+k(5)$.

Let $D=$ the sum of the distinct x-values for which $(|x-2|-2)^{|x+1|}=1$.

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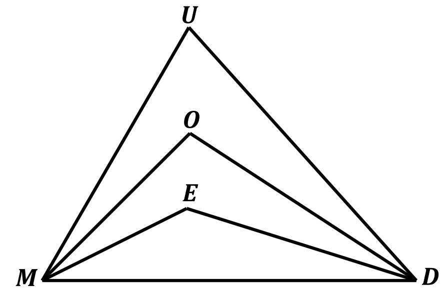
Question #3 Theta Bowl
MAΘ National Convention 2025

In $\triangle MUD$, $m\angle U = 111°$; $\overline{DO}$ and $\overline{DE}$ trisect $\angle D$; and $\overline{MO}$ and $\overline{ME}$ trisect $\angle M$. Let $A =$ the degree measure of $\angle MOD$.



Seven consecutive integers have a product of 32,432,400.
Let $B =$ the largest of the seven integers.

Let $C =$ the largest three-digit number divisible by both 3 and 17.

Let $D =$ the number of positive integers less than 1000 that are divisible by neither 5 nor 7.

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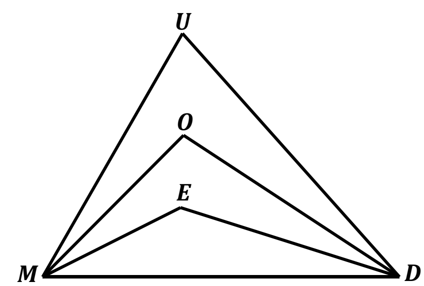

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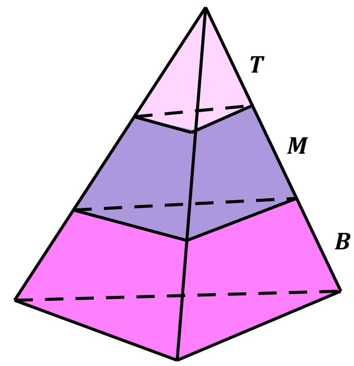
Question #4 Theta Bowl
MAΘ National Convention 2025



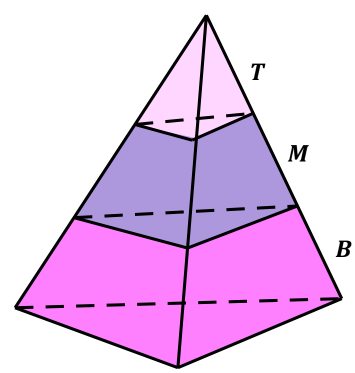
Two planes parallel to the base of a tetrahedron form three pieces, T (top), M (middle) and B (bottom), all with equal heights. Let $A =$ the volume of part B (the bottom), if the volume of part T (the top) is 3.

Equilateral triangle PIG has vertices $P(a, b)$, $I(1, -1)$, and $G(9, -1)$. Point P is in Quadrant I. Let $B = a + b$.

A point starts at the origin and moves in the following pattern:
$(0,0) \to (1,-1) \to (3,1) \to (0,4) \to (-4,0) \to (1,-5) \to (7,1) \to (0,8) \to \ldots$
Let $C =$ the coordinates (written as an ordered pair) of the point's position after 2025 moves.

A line passes through the point $(-1, -2)$. The line does not pass through Quadrant II. Let $D =$ the range of values of the possible slopes of the line, written in interval notation.

Question #4 Theta Bowl
MAΘ National Convention 2025



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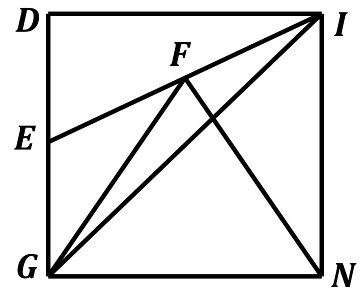
Question #5 Theta Bowl
MAΘ National Convention 2025



Equilateral triangle *FNG* is in square *DING*, as shown.
Let $A =$ the degree measure of $m\angle DEI + m\angle EIG + m\angle EFG$.

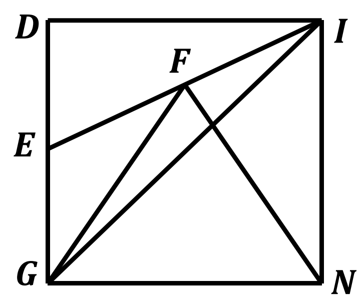
Suppose *a*, *b*, *c*, and *d* are positive integers such that $a + \cfrac{1}{b + \cfrac{1}{c + \cfrac{1}{d}}} = \frac{37}{11}$.

Let $B = a + b + c + d$.

When randomly choosing two numbers from the set $\{1, 3, 5, 7, 9\}$ with replacement, what is the probability that the product of the two numbers is greater than 40? Let $C =$ the probability written as a percent. (You may leave off the %.)

The diagonal of a square has length $8\sqrt{11}$. Let $D =$ the sum of the lengths of the square's semiperimeter and apothem.

Question #5 Theta Bowl
MAΘ National Convention 2025



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Question #6 Theta Bowl
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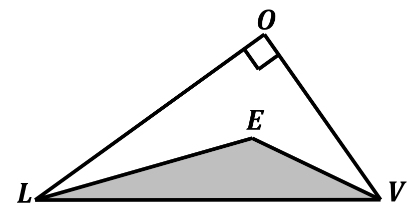


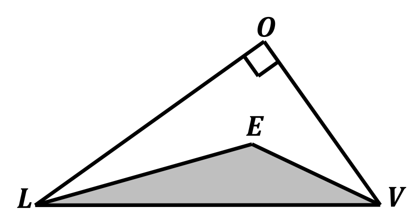
In right triangle LOV, $OV = 5$, $LV = 13$, $m\angle O = 90°$, and E is the centroid. Let $A =$ the area of $\triangle LEV$.

When $x^3 + bx^2 + cx + d$ is divided by $x+1$, $x-1$, and $x-2$, the remainders are −3, 9, and 12, respectively. Let $B = b + c + d$.

Let $C =$ the solution, written in interval notation, to $2\log_5 x - \log_x 125 < 1$.

A cargo truck comes up on an accident, one hour after departing its warehouse. The cargo truck is at a full stop for half an hour, then proceeds at three-fourths its former rate, arriving 3.5 hours late. Had the accident occurred 90 miles farther along the road, the truck would have arrived only 3 hours late. Let $D =$ the length of the trip, in miles.

Question #6 Theta Bowl
MAΘ National Convention 2025



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Question #7 Theta Bowl
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A bridge in the shape of a parabolic arch is 50 feet high at the center and 150 feet wide at the bottom. Let $A =$ the height of the bridge 30 feet from the center.

Let $B =$ the coefficient of x^4 in the expansion of $\left(1-2x^3\right)^5\left(1+x\right)^8$.

Four integers—a, b, c, and d—are independently chosen at random from the set $\{1, 2, 3, ..., 9, 10\}$. If $X = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, let $C =$ the probability that $\det X$ is even.

The ellipse $x^2 + 4y^2 = 4$ is inscribed in a rectangle whose sides are parallel to the coordinate axes, and the rectangle is inscribed in another ellipse that passes through (4, 0). The equation of the larger ellipse can be written in the form $x^2 + my^2 = n$. Let $D = m + n$.

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Question #8 Theta Bowl
MAΘ National Convention 2025

Quadrilateral *MYTH* has vertices $M(-2, 0)$, $Y(4, 0)$, and $T(1, 3)$. Point *H* is the image of *T* reflected about the origin. Let $A =$ the area of quadrilateral *MYTH.*

Let $B =$ the complex number *z* satisfies the equation $\sqrt{z} = \dfrac{25}{1-2i} + \dfrac{15}{2+i}$, where $i = \sqrt{-1}$. Write your answer in $a + bi$ form.

The value of *x* which satisfies $\left(3^{2x-1}\right)\left(4^{3x+1}\right) = 6^{x+3}$ can be written in the form $x = \dfrac{\ln a}{\ln b}$, where *a* and *b* are integers. Let $C = a + b$.

Let $D = f + g$ if $\begin{cases} 3x - 2y - 4z = 7 \\ 2x + y + 5z = f \\ x - 10y + gz = 1 \end{cases}$ has an infinite number of solutions.

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Question #9 Theta Bowl
MAΘ National Convention 2025

A geometric series has all positive terms. The sum of the first three terms is 37, and the sum to infinity is 64. Let $A =$ the second term of the geometric series.

Let $B = E + F + G + H + I + J$, if $9(EFGHIJ) = 4(HIJEFG)$, where A, B, C, D, E, and F are six unique digits, and EFGHIJ and HIJEFG are six-digit numbers.

The earth travels around the sun in an elliptical orbit, where the sun serves as one of the foci. The maximum distance of the earth from the sun is 9.3×10^7 miles, and the minimum distance of the earth from the sun is 9.1×10^7 miles. Let $C =$ the distance, in miles, from the sun to the other focus. Do NOT write your answer in scientific notation.

All of the even numbers from 2 to 98 inclusive—except those ending in 0—are multiplied together. Let $D =$ the units digit of the product.

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Question #10 Theta Bowl
MAΘ National Convention 2025

In her coin purse, Lady Gifford has pennies, dimes, and nickels totaling $1.62. Half of the coins are nickels. Let $A =$ the number of ways this can be configured, given that she has at least one of each coin.

The 120 permutations of CHRIS are arranged in alphabetical order. Let $B =$ the 86th "word" in the list.

Let $C =$ the coefficient of $a^8b^4c^9d^9$ in the expansion of $\left(abc+abd+acd+bcd\right)^{10}$.

At the conclusion of a 10-person spelling bee, all the contestants win one of 10 gift cards. The gift cards are all placed in a bag, and the contestants select a card from those remaining in the bag. There are five cards for Taco Bell, three cards for McDonald's, and two cards for Arby's. Let $D =$ the probability that when the 8th contestant goes to select the prize, one of each card remains in the bag. Write your answer as a fraction.

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Question #11 Theta Bowl
MAΘ National Convention 2025

Let ω be one of the two imaginary roots of $x^3 = 1$. A fair, six-sided die is thrown three times. If *a*, *b*, and *c* are the numbers obtained from the die, let $A =$ the probability that $\omega^a + \omega^b + \omega^c = 0$. Write your answer as a fraction.

If $x = 3 + 2\sqrt{2}$, let $B =$ the value of $x^4 + \frac{1}{x^4}$.

The solution to $\left|\frac{x^2 - 5x + 4}{x^2 - 4}\right| \le 1$ can be written in interval notation in the form $[a, b] \cup [c, d)$. Let $C =$ the product *bc*.

Let $D =$ the value of $\sum_{n=2}^{90} \frac{2}{n^2 - n}$.

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Question #12 Theta Bowl
MAΘ National Convention 2025

Let $A =$ the positive difference in the solutions to $\log\left(64 \cdot \sqrt[24]{2^{x^2-40x}}\right) = 0$.

The sum of 25 natural numbers in arithmetic progression lies between 1900 and 2000, and the ninth term of the progression is 55. Let $B =$ the first term of the progression.

Let $C =$ the solution(s) to $2x^2 - 5x + \sqrt{2x^2 - 5x + 11} = 1$.

Let $D =$ the value of $\sqrt[3]{\dfrac{\sqrt{112} - \sqrt{9072}}{\sqrt{112}}} - \sqrt[4]{\dfrac{\sqrt{1008} - \sqrt{448}}{\sqrt{112}}}$.

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Question #13 Theta Bowl
MAΘ National Convention 2025

Consider a pentagonal prism. Let $E =$ the number of edges of the prism, $V =$ the number of vertices of the prism, $F =$ the number of faces of the prism, and $S =$ the number of sides of the prism. Let $A = \frac{E+V+2S}{F}$.

Let $B =$ the number of integers x for which a triangle with side lengths 10, 24, and x has all acute angles.

Three of the roots of $x^4 + ax^2 + bx + c = 0$ are 1, 2, and 3. Let $C = a + c$.

The roots of $x^2 - 109x + f = 0$ are p and q, and it is known that $200p + 4q = 2004$. Let $D =$ the value of f.

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