

#0 Alpha School Bowl
MAΘ National Convention 2026

$$A = (f \circ g^{-1})(4) \text{ if } f(x) = \frac{2^x}{32} \text{ and } g(x) = -2x.$$

$B =$ the area enclosed by the triangle with vertices at the cube roots of unity.

$$C = 7 + 9 - 3 \times 20 \div 5 - 19.$$

$D =$ the product of the number of faces, edges, and space diagonals of a tetrahedron.

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Let $f(x) = (\log_{\sqrt{3}} 2187) \sin[4(\log 0.001)x - \pi e^{\ln 400}] + \log 10,000$. Angles are measured in radians.

A = the amplitude of $f(x)$.

B = the period of $f(x)$.

C = the least possible non-negative phase shift to turn

$g(x) = (\log_{\sqrt{3}} 2187) \sin[4(\log 0.001)x] + \log 10,000$ into $f(x)$.

D = the vertical shift to turn $h(x) = (\log_{\sqrt{3}} 2187) \sin[4(\log 0.001)x - \pi e^{\ln 400}]$ into $f(x)$.

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#2 Alpha School Bowl
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A = the probability that a seven-digit number consisting of two 3s, three 4s, and two 5s is divisible by 2.

Two numbers are randomly selected one by one and without replacement from the set $\{1, 2, 3, 4, 5, 6\}$.

B = the probability that the minimum of the two numbers is less than 4.

Three vertices of a regular hexagon are chosen at random. C = the probability that the triangle having these three vertices is equilateral.

D = the probability that a real number x chosen from the interval $[1, 10]$ satisfies $0.2x \leq 1$.

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#3 Alpha School Bowl
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$A =$ the simplest form of $\frac{p^2-1}{p^2+1}$, where defined, if $p = \sec x + \tan x$.

The 10th term of an arithmetic sequence is 52 and the 17th term is 20 more than the 13th term.
 $B =$ the 2026th term of this sequence.

The sum of the first n terms of an arithmetic sequence is $4n^2 + 2n$. $C =$ the n^{th} term of this sequence, in terms of n .

An airplane, flying at an altitude of 1200 meters, observes two boats in a lake sailing towards it in the same direction. The angles of depression from the airplane to the two boats are 60° and 30° . $D =$ the distance between the two boats, in meters.

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$A =$ the number of distinct solutions of $\log_{\frac{1}{2}}|\sin x| = 2 - \log_{\frac{1}{2}}|\cos x|$ over the interval $[0, 3\pi]$.

$$B = (0.05)^{\log_{\sqrt{20}}(0.1 + 0.01 + 0.001 + \dots + (0.1)^n + \dots)}.$$

A go-kart track is to be constructed using two opposite sides of a rectangle that are connected to each other by two semicircles, as in the diagram to the right. The perimeter of the track is to be 200 meters. The owners of the track want the area of the rectangular region to be maximized. $C =$ the total area enclosed by the track.



$D =$ Let $D =$ the minimum value of $y = \sqrt{x^2 - 4x + 7}$.

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$$A = \lim_{x \rightarrow 0} \left(\frac{(2+x)^{-1} - 2^{-1}}{x} \right)$$

$$B = \lim_{x \rightarrow -\infty} \left(\frac{5e^{-5x} - 3e^{7x}}{6e^{7x} - 4e^{-5x}} \right)$$

$$C = \lim_{x \rightarrow 7^-} \left(e^{\frac{4}{x-7}} \right)$$

$$D = \lim_{x \rightarrow 2} \left(\frac{\sqrt{6-x} - 2}{3 - \sqrt{11-x}} \right)$$

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#6 Alpha School Bowl
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Given: The polar equation $r = \frac{9}{3 - 2\cos\theta}$.

A = the length of the minor axis (from one co-vertex to the other)

B = the product of the eccentricity and focal width

C = the center, written in Cartesian (rectangular) coordinates

D = the sum of the length of the major axis (from one vertex to the other) and the distance between foci

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#7 Alpha School Bowl
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$A =$ the number of integers in the solution set of $\frac{x^2 + 4x + 3}{x^2 - 2x - 8} \leq 0$.

$B =$ the number of integers in the solution set of $\log\left(\frac{2x - 2026}{x + 1}\right) \leq 0$.

$C =$ the least positive integer n for which $n^{300} > 13^{200}$.

The solution set to $\cot^2 x - \csc x + 1 > 0$ over the interval $[0, 2\pi]$ can be written in interval notation as $(a, b) \cup (c, d) \cup (e, f)$, where $a \leq b \leq c \leq d \leq e \leq f$. $D = \frac{f}{b + c + d} + \frac{a}{e}$.

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#8 Alpha School Bowl
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A = the number of distinct 3×3 matrices whose entries are all either 0 or 1 and whose sum of all entries is a prime number.

B = the sum of the squares of all complex values of x such that $\det(MN) = 0$ if $M = \begin{bmatrix} 1 & -2 & x \\ x & 2 & -1 \end{bmatrix}$ and

$$N = \begin{bmatrix} 2 & x \\ -1 & 2 \\ 4 & -5 \end{bmatrix}.$$

C = the real value of x such that $\begin{vmatrix} x & 8 \\ 3 & 1 \end{vmatrix} = \begin{vmatrix} 4 & x \\ 3 & 1 \end{vmatrix}$.

D = the real value of x such that $\begin{bmatrix} 3 & x \\ -2 & -3 \end{bmatrix}$ is equal to its own inverse.

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#9 Alpha School Bowl
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Please note that capitalized inverse trig functions refer to principal values.

$$A = \sin \left[2 \operatorname{Arctan} \left(-\frac{11}{6} \right) \right].$$

$$B = \text{the value(s) of } x \text{ for which } \sin^{-1} x = \frac{\pi}{6} + \cos^{-1} x.$$

$$C = \lim_{x \rightarrow \infty} (8 \operatorname{Arctan}(0.4x))$$

$$D = \text{the area bounded by } y = \operatorname{Arcsin}(\sin x) \text{ and the } x\text{-axis on the interval } [0, 4\pi].$$

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#10 Alpha School Bowl
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$A =$ the coefficient of $\frac{1}{x^3}$ in the expansion of $\left(8x^3 - 12x + \frac{6}{x} - \frac{1}{x^3}\right)^3$.

In the expansion of $\left(\frac{\sqrt{3}}{2} - \sqrt[3]{2}x\right)^5$, only one term has an integer coefficient. $B =$ this integer coefficient.

$C =$ the number of terms in the simplified expansion of $(a+b)(c+d+e)(f+g+h+k)$.

$D =$ the coefficient of $x^{-\frac{1}{2}}$ in the expansion of $\left(x - x^{-\frac{1}{2}}\right)^7$.

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#11 Alpha School Bowl
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$$A = g_{2026} \text{ if } g_1 = 2 \text{ and } g_{n+1} = \frac{1+g_n}{1-g_n}, \text{ for integers } n \geq 1.$$

$$B = \frac{(5\text{cis}153^\circ)(2\text{cis}49^\circ)(3\text{cis}238^\circ)}{\sqrt{5}\text{cis}260^\circ}.$$

$$C = \sum_{n=2}^7 \frac{1}{n^2-1}$$

$$D = \text{the remainder when } 5^{2027} \text{ is divided by } 11.$$

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#12 Alpha School Bowl
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$A =$ all values of x on the interval $[0, 2\pi]$ for which $\log_2(-3\sin x) = 2\log_2(\cos x) + 1$.

$B =$ the sum of all x on the interval $[\pi, 2\pi]$ for which $\tan\left(\frac{5}{4}\pi + x\right) + \tan\left(\frac{5}{4}\pi - x\right) = 4$.

$C =$ the sum of all x on the interval $[\pi, 3\pi]$ for which $\left|\sin\frac{1}{2}x\right| = |\cos x|$.

$D =$ all values of x on the interval $[-2\pi, 0]$ for which $\sin 2x = 3\cos x$.

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#13 Alpha School Bowl
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$A =$ the value of $f(2)$ for the monic cubic function $f(x)$ with roots at -1 , 1 , and 3 .

$B =$ the magnitude of the projection of $\overrightarrow{MN}$ onto $\overrightarrow{PQ}$ if $M(1, -1, 1)$, $N(2, -1, 3)$, $P(2, 0, -3)$, and $Q(3, -2, 1)$.

$C =$ the number of radians the hour hand of a clock turns in 4 hours and 48 minutes.

$D =$ the product of the roots of $3|x|^2 - 19|x| - 14 = 0$.

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$D =$ the product of the roots of $3|x|^2 - 19|x| - 14 = 0$.

#14 Alpha School Bowl
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$A =$ the remainder when $x^4 + x^2 + x + 1$ is divided by $x^2 - 1$.

$B =$ the value of $a + 2b + 3c$ if $3x(2 - (3 - 5x)) = ax^2 + bx + c$ is true for all values of x .

$C =$ the carrying capacity (theoretical maximum population) of Sudden Valley, whose population can be modeled by $P(t) = \frac{40,000}{5 + 8e^{-0.03t}}$.

$D =$ the distance between the polar points $\left(4, \frac{7}{12}\pi\right)$ and $\left(3, \frac{5}{4}\pi\right)$.

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