Alpha Ciphering
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Question #0

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#0 Alpha Ciphering
MAΘ National Convention 2024

Find the period of the function

$$f(x) = cos^4 x - sin^4 x$$

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Question #1

#1 Alpha Ciphering
MAΘ National Convention 2024

What is the sum of the 2 largest prime factors of $2^{14}+1$?

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Question #2

#2 Alpha Ciphering
MAΘ National Convention 2024

Alice, Bob, and Carol ran a race. Alice beat Bob by 40 meters, Bob beat Carol by 20 meters, and Alice beat Carol by 56 meters. The race was L meters long and they all ran at uniform speeds. What is L?

#2 Alpha Ciphering
MAΘ National Convention 2024

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MAΘ National Convention 2024

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MAΘ National Convention 2024

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Alpha Ciphering
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Question #3

#3 Alpha Ciphering
MAΘ National Convention 2024

A hyperbola with foci at $(0,5)$ and $(0,-5)$ has asymptotes whose slopes are 2 and -2. The equation for this hyperbola can be written in the form

$$\frac{(y-k)^2}{a^2} - \frac{(x-h)^2}{b^2} = 1$$

What is the value of $h + k + a^2 - b^2$?

#3 Alpha Ciphering
MAΘ National Convention 2024

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MAΘ National Convention 2024

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MAΘ National Convention 2024

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Alpha Ciphering
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Question #4

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Question #4

Alpha Ciphering
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Question #4

#4 Alpha Ciphering
MAΘ National Convention 2024

Evaluate: $\lim_{x\to\infty}\left(\sqrt{2x^2+x+7}-\sqrt{2x^2-x}\right)$

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MAΘ National Convention 2024

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Alpha Ciphering
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#5 Alpha Ciphering
MAΘ National Convention 2024

The longest side of a triangle is 6 and the other 2 sides are in the ratio of 2:1. One of the angles of the triangle measures 120°. What is the sum of all possible product of the lengths of the 2 shorter sides?

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MAΘ National Convention 2024

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MAΘ National Convention 2024

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MAΘ National Convention 2024

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Question #6

#6 Alpha Ciphering
MAΘ National Convention 2024

When $\left(5\sqrt{2}, 5\sqrt{6}\right)$ is rotated $\frac{2\pi}{3}$ counterclockwise about the origin, the resulting point in rectangular coordinate system is (X, Y). Compute $X + Y$.

#6 Alpha Ciphering
MAΘ National Convention 2024

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Alpha Ciphering
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Alpha Ciphering
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Question #7

#7 Alpha Ciphering
MAΘ National Convention 2024

How many positive integers less than 1000 are there such that the digits are NOT in strictly increasing order from left to right? (5, 89, or 249 would be an example of strictly increasing whereas 83, 352, or 777 would not be).

#7 Alpha Ciphering
MAΘ National Convention 2024

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MAΘ National Convention 2024

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Alpha Ciphering
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#8 Alpha Ciphering
MAΘ National Convention 2024

Turner has two poles in his backyard that are 10 yards apart and they are tied together with a rope 20 yards long. His dog Hooch's collar is attached to this rope, in such a way that Hooch can slide freely along the rope. What is the area, in square yards, of the yard in which Hooch can travel? Assume the ends of the rope are at ground level, the ground is flat, and the sizes of the dog and collar are negligible.

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MAΘ National Convention 2024

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MAΘ National Convention 2024

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MAΘ National Convention 2024

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Alpha Ciphering
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#9 Alpha Ciphering
MAΘ National Convention 2024

Given $x \neq \frac{k\pi}{2}$ for all integer k. The range of $f(x) = \frac{3\sin x\cos^2 x+\cos^4 x\sin x+3\sin^3 x+\cos^2 x\sin^3 x}{\sec x\tan x-\sin x\tan^2 x}$ is (A, B). Compute AB.

#9 Alpha Ciphering
MAΘ National Convention 2024

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Alpha Ciphering
Test #621
Question #10

Alpha Ciphering
Test #621
Question #10

Alpha Ciphering
Test #621
Question #10

#10 Alpha Ciphering
MAΘ National Convention 2024

In how many positive 4-digit integers have digits that form an arithmetic sequence with non-zero common difference? (The digits may not be rearranged)

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MAΘ National Convention 2024

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Alpha Ciphering
Test #621
Question #11

Alpha Ciphering
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Alpha Ciphering
Test #621
Question #11

#11 Alpha Ciphering
MAΘ National Convention 2024

Solve for k: $2\arctan\frac{1}{3} = \arctan k - \frac{\pi}{4}$

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Alpha Ciphering
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Test #621
Question #12

Alpha Ciphering
Test #621
Question #12

Alpha Ciphering
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Question #12

#12 Alpha Ciphering
MAΘ National Convention 2024

3 congruent circles of radius 3 are placed so that each is externally tangent to the other 2. A smaller circle is placed in the middle so that it is tangent to all 3 of the larger circles. What is its radius?

#12 Alpha Ciphering
MAΘ National Convention 2024

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MAΘ National Convention 2024

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MAΘ National Convention 2024

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