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#0 Mu Ciphering
MAΘ National Convention 2024

Find the equation of the line tangent to the graph $y = \sin x + x$ at the point (0, 0).

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#1 Mu Ciphering
MAΘ National Convention 2024

$\mathcal{R}$ is the region bounded by the graphs of $h(x) = 4x - x^2$ and $g(x) = x^2$. $\mathcal{R}$ is rotated about the x-axis to produce a solid with volume A. $\mathcal{R}$ is rotated about the line $x = 3$ to produce a second solid with volume B. Compute $A + B$.

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#2 Mu Ciphering
MAΘ National Convention 2024

Two spherical surfaces intersect in a circle. If their radii are 6 and 4, and centers are 8 apart, compute the radius of this circle.

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#3 Mu Ciphering
MAΘ National Convention 2024

A right circular cone is shrinking so that its height and base radius are always in the same ratio. When the radius is 6 cm and the height is 8 cm, the volume is decreasing at 2 cubic cm per minute. At that time, find the rate at which the surface area of the cone is decreasing, in square cm per minute.

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MAΘ National Convention 2024

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#4 Mu Ciphering
MAΘ National Convention 2024

In pentagon HOUSE, Angles U and E are both right angles and the degree measure of angle S is 120. If $EH = OU = 18$, $OH = 12$, and $ES = US$, what is US?

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MAΘ National Convention 2024

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#5 Mu Ciphering
MAΘ National Convention 2024

Find the slope of the line tangent to the polar graph $r = -3\sin 2\theta$ at $\theta = \frac{\pi}{6}$.

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#6 Mu Ciphering
MAΘ National Convention 2024

Alice and Bob each roll 2 fair 6-sided die. What is the probability that the product of their individual sums is greater than 100?

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#7 Mu Ciphering
MAΘ National Convention 2024

$f(x)$ is a cubic function with rational coefficients. It has a local maximum at $(-1,48)$ and a point of inflection at $(2,-6)$. What is the sum of the coefficients of this function?

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MAΘ National Convention 2024

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#8 Mu Ciphering
MAΘ National Convention 2024

For k > 0, compute the minimum value of

$$8k^3 + 36k + \frac{54}{k} + \frac{27}{k^3}$$

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#9 Mu Ciphering
MAΘ National Convention 2024

Compute $\int_{-5}^{2}|x^3 - 2x^2 - 9x + 18|\, dx$.

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#10 Mu Ciphering
MAΘ National Convention 2024

In triangle ABC, the incircle is tangent to side AB at point D. If $AD = 20$ and $BD = 101$, what is the greatest possible integer value for the inradius?

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#11 Mu Ciphering
MAΘ National Convention 2024

Compute

$$\int_0^{\frac{\pi}{4}} \frac{\sin x}{1+\cos x-\sin^2 x}\,dx$$

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#12 Mu Ciphering
MAΘ National Convention 2024

A and B are positive integers such that

$$\frac{1}{A}+\frac{1}{B}+\frac{1}{AB}=\frac{3}{10}$$

What is the sum of all possible values for A?

#12 Mu Ciphering
MAΘ National Convention 2024

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