#0 Mu Ciphering
MAΘ National Convention 2019

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A line with negative slope passes through $(2,0)$ and is tangent to $\frac{x^2}{2}+\frac{y^2}{1}=1$. The line can be written in the form $y = mx + b$. Compute $\frac{b}{m}$.

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Evaluate the improper integral:

$$\int_{-7}^{2} \frac{dx}{(x-1)^{\frac{2}{3}}}$$

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Right triangle ZLU is inscribed in a circle, with radius 24 and hypotenuse $\overline{ZL}$. $m\angle Z$ is increasing at a rate of 10° per minute as U moves along the circumference of the circle (while Z and L remain fixed). The area of the triangle is changing at $k\pi$ square units per minute when $m\angle Z = 30^\circ$. What is *k*?

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The area bounded by $y = \arctan x$, $x = 0$, and $y = \frac{\pi}{4}$ is L. Compute e^{8L}.

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A particle moves along the *x*-axis so that $v(t) = t^2 - 3t$ for $0 \le t \le 4$. If its position at time 0 is 4, what is the greatest distance between the particle and the origin?

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If a banquet hall sells tickets at a price of $\$L$ each, then $200 - 4L$ tickets will be sold. Each event costs the banquet hall \$200, plus an additional \$10 per person. How much should they charge, in dollars per ticket, to maximize their profit?

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What is the total area between the curves $y = -6x$ and $y = 6x^2 - 18x$ for $1 \leq x \leq 3$?

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The region bounded by the x-axis, $y = x - 2$, and $y = \sqrt{x}$ is revolved about the x-axis. The volume is $\frac{L\pi}{U}$, where L and U are relatively prime positive integers. What is $L + U$?

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The region bounded by $y = -x^2 + x$ and the x-axis is L. Region L is the base of a solid, and cross sections of this solid perpendicular to the x-axis are isosceles right triangles with hypotenuses on L. What is the volume of this solid?

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Let f and h be functions satisfying:

$$\big(h(x)\big)^3 = f^{-1}(6057x - 6057)$$

Compute:

$$\big(h(x)\big)^2 h'(x) f'\Big(\big(h(x)\big)^3\Big)$$

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