2025 MAΘ National Convention Calculus Hustle: Problem #1

A function $y = f(x)$ has tangent lines whose slopes satisfy $m = 1 + x + x^2$ for all x such that $0 < x < 5$. At $x = 2$, the function has a tangent line whose equation is $y - 7x = 2$. Compute $f(4)$.

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #1

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Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #2

A rotated parabola is described by the set of points (x, y) that satisfies the equation

$$x^2 - 2xy + y^2 + x = 0$$

This rotated parabola has a horizontal tangent line at the point (a, b). Find $a - b$.

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #2

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Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #3

Suppose f is a $2\pi-$periodic and integrable function (i.e. $f(x+2\pi) = f(x)$ for all x.) Suppose $\int_{-\pi}^{\pi} f(x)\mathrm{d}x = 10$. Evaluate

$$\int_{\pi}^{3\pi} (f(x)+\pi)\mathrm{d}x$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #3

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Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #4

Let $f(x) = \dfrac{1}{x}$. Calculate

$$\lim_{h \to 0} \frac{f(x+2h) + f(x) - 2f(x+h)}{h^2}$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #4

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2025 MAΘ National Convention
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2025 MAΘ National Convention
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Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #5

Compute

$$\int_0^{\pi/4} \frac{1}{(\sin x + \cos x)^2} \mathrm{d}x$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #5

Compute

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2025 MAΘ National Convention
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Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #6

The perimeter of the region $\mathcal{R}$ in the first quadrant bounded by the curves $y = \ln x$, $x = 1$ and $x = 2$ is of the form

$$\int_1^2 \frac{\sqrt{1+x^2}}{x}\mathrm{d}x + A$$

Where A is a real number. Find A.

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #6

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Where A is a real number. Find A.

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #7

Compute

$$\lim_{x \to 1} \frac{\cos x - \cos 1}{1 - x}$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #7

Compute

$$\lim_{x \to 1} \frac{\cos x - \cos 1}{1 - x}$$

Answer: _____

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2025 MAΘ National Convention
Calculus Hustle: Problem #7

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Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #7

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$$\lim_{x \to 1} \frac{\cos x - \cos 1}{1 - x}$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #8

A shape has a base bound by the curve $y = 2x$ between $x = -3$ and $x = 2$. Cross sections of the shape are squares perpendicular to the x-axis. Find the volume of the solid.

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #8

A shape has a base bound by the curve $y = 2x$ between $x = -3$ and $x = 2$. Cross sections of the shape are squares perpendicular to the x-axis. Find the volume of the solid.

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Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #9

Compute the sum of the following convergent series

$$\sum_{n=2}^{\infty} 3^{-2n}$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #9

Compute the sum of the following convergent series

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2025 MAΘ National Convention Calculus Hustle: Problem #9

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$$\sum_{n=2}^{\infty} 3^{-2n}$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #10

Compute

$$\int_{-2}^{2} |x + |x||\mathrm{d}x$$

Answer: _____

Round: 1 2 3 4 5

2025 MAΘ National Convention Calculus Hustle: Problem #10

Compute

$$\int_{-2}^{2} |x + |x||\mathrm{d}x$$

Answer: _____

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$$\int_{-2}^{2} |x + |x||\mathrm{d}x$$

Answer: _____

Round: 1 2 3 4 5

2025 MAΘ National Convention Calculus Hustle: Problem #10

Compute

$$\int_{-2}^{2} |x + |x||\mathrm{d}x$$

Answer: _____

Round: 1 2 3 4 5

2025 MAΘ National Convention
Calculus Hustle: Problem #11

Evaluate:

$$\lim_{x\to 4}\left(\frac{x}{x-4}\int_4^x \frac{\sin t}{t}\right)\mathrm{d}x$$

Answer: _____

Round: 1 2 3 4 5

2025 MAΘ National Convention
Calculus Hustle: Problem #11

Evaluate:

$$\lim_{x\to 4}\left(\frac{x}{x-4}\int_4^x \frac{\sin t}{t}\right)\mathrm{d}x$$

Answer: _____

Round: 1 2 3 4 5

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Round: 1 2 3 4 5

2025 MAΘ National Convention
Calculus Hustle: Problem #12

Compute the area inside both polar curves
$r = 2$ and $r = 4\cos\theta$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #12

Compute the area inside both polar curves
$r = 2$ and $r = 4\cos\theta$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
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$r = 2$ and $r = 4\cos\theta$

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Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #13

The area bounded by the coordinate axes and the tangent line to $x^2 + 2x + y - 3 = 0$ at the point where it meets the y-axis is

Answer: _______________

Round: 1 2 3 4 5

2025 MAΘ National Convention
Calculus Hustle: Problem #13

The area bounded by the coordinate axes and the tangent line to $x^2 + 2x + y - 3 = 0$ at the point where it meets the y-axis is

Answer: _______________

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Answer: _______________

Round: 1 2 3 4 5

2025 MAΘ National Convention
Calculus Hustle: Problem #14

Compute

$$\int_{1}^{7/2} \min(x - \lfloor x \rfloor, -x - \lfloor -x \rfloor)\mathrm{d}x$$

Answer: ________________

Round: 1 2 3 4 5

2025 MAΘ National Convention
Calculus Hustle: Problem #14

Compute

$$\int_{1}^{7/2} \min(x - \lfloor x \rfloor, -x - \lfloor -x \rfloor)\mathrm{d}x$$

Answer: ________________

Round: 1 2 3 4 5

2025 MAΘ National Convention
Calculus Hustle: Problem #14

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Answer: ________________

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2025 MAΘ National Convention
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Answer: ________________

Round: 1 2 3 4 5

2025 MAΘ National Convention
Calculus Hustle: Problem #15

Compute

$$\int_{-2}^{2} \frac{|x| + x}{x^2 + 1} \mathrm{d}x$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #15

Compute

$$\int_{-2}^{2} \frac{|x| + x}{x^2 + 1} \mathrm{d}x$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #15

Compute

$$\int_{-2}^{2} \frac{|x| + x}{x^2 + 1} \mathrm{d}x$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #15

Compute

$$\int_{-2}^{2} \frac{|x| + x}{x^2 + 1} \mathrm{d}x$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #16

A function satisfies

$$\frac{\mathrm{d}f}{\mathrm{d}x} = 1 - x$$

If the function passes through the point $f(-1) = 3$, find $f(2)$.

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #16

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Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #17

A bug is moving along a parametric curve described by the equations

$$\begin{cases} x = \sin t + t \\ y = t - \cos t \end{cases}$$

on the interval $[0, 8]$. Find the speed of the particle at the moment when $t = \dfrac{\pi}{2}$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #17

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Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #18

The region $\mathcal{R}$, bounded by the coordinate axes and the line $x + y = 1$ is the base of a solid with cross sections perpendicular to the x-axis whose area is given by $A(x) = xe^{-x}$. Compute the volume of the region.

Answer: ______________

Round: 1 2 3 4 5

2025 MAΘ National Convention
Calculus Hustle: Problem #18

The region $\mathcal{R}$, bounded by the coordinate axes and the line $x + y = 1$ is the base of a solid with cross sections perpendicular to the x-axis whose area is given by $A(x) = xe^{-x}$. Compute the volume of the region.

Answer: ______________

Round: 1 2 3 4 5

2025 MAΘ National Convention
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2025 MAΘ National Convention
Calculus Hustle: Problem #18

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Answer: ______________

Round: 1 2 3 4 5

2025 MAΘ National Convention
Calculus Hustle: Problem #19

Suppose the series $\sum_{n=1}^{\infty} a_n$ is convergent.

Compute $\lim_{n\to\infty} \frac{1+a_n}{\cos\left(\frac{1}{n}\right)}$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #19

Suppose the series $\sum_{n=1}^{\infty} a_n$ is convergent.

Compute $\lim_{n\to\infty} \frac{1+a_n}{\cos\left(\frac{1}{n}\right)}$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #19

Suppose the series $\sum_{n=1}^{\infty} a_n$ is convergent.

Compute $\lim_{n\to\infty} \frac{1+a_n}{\cos\left(\frac{1}{n}\right)}$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention
Calculus Hustle: Problem #19

Suppose the series $\sum_{n=1}^{\infty} a_n$ is convergent.

Compute $\lim_{n\to\infty} \frac{1+a_n}{\cos\left(\frac{1}{n}\right)}$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #20

Compute

$$\lim_{n\to\infty} \frac{\pi}{n} \sum_{k=1}^{n} \frac{k\pi}{n} \sin\left(\frac{k\pi}{n}\right)$$

Answer: _____

Round: 1 2 3 4 5

2025 MAΘ National Convention Calculus Hustle: Problem #20

Compute

$$\lim_{n\to\infty} \frac{\pi}{n} \sum_{k=1}^{n} \frac{k\pi}{n} \sin\left(\frac{k\pi}{n}\right)$$

Answer: _____

Round: 1 2 3 4 5

2025 MAΘ National Convention Calculus Hustle: Problem #20

Compute

$$\lim_{n\to\infty} \frac{\pi}{n} \sum_{k=1}^{n} \frac{k\pi}{n} \sin\left(\frac{k\pi}{n}\right)$$

Answer: _____

Round: 1 2 3 4 5

2025 MAΘ National Convention Calculus Hustle: Problem #20

Compute

$$\lim_{n\to\infty} \frac{\pi}{n} \sum_{k=1}^{n} \frac{k\pi}{n} \sin\left(\frac{k\pi}{n}\right)$$

Answer: _____

Round: 1 2 3 4 5

2025 MAΘ National Convention Calculus Hustle: Problem #21

Compute the total area of the polar regions bounded by the curves $\mathcal{C}_1 : r = |\sin\theta|$ and $\mathcal{C}_2 : r = -1$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #21

Compute the total area of the polar regions bounded by the curves $\mathcal{C}_1 : r = |\sin\theta|$ and $\mathcal{C}_2 : r = -1$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #21

Compute the total area of the polar regions bounded by the curves $\mathcal{C}_1 : r = |\sin\theta|$ and $\mathcal{C}_2 : r = -1$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #21

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Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #22

Compute

$$\lim_{x \to 1} \frac{1 - x^5}{1 - x^7}$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #22

Compute

$$\lim_{x \to 1} \frac{1 - x^5}{1 - x^7}$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #22

Compute

$$\lim_{x \to 1} \frac{1 - x^5}{1 - x^7}$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #22

Compute

$$\lim_{x \to 1} \frac{1 - x^5}{1 - x^7}$$

Answer: _____

Round: **1** **2** **3** **4** **5**

2025 MAΘ National Convention Calculus Hustle: Problem #23

The function $f(x) = x - \ln(1+x)$ converges to its Maclaurin expansion

$$\sum_{n=0}^{\infty} \frac{(-1)^n x^{n+2}}{n+2}$$

on an appropriate interval of convergence. Let $G(x) = \sin(x^2) f(x)$. Compute $G^{(4)}(0)$.

Answer: _____

Round: 1 2 3 4 5

2025 MAΘ National Convention Calculus Hustle: Problem #23

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$$\sum_{n=0}^{\infty} \frac{(-1)^n x^{n+2}}{n+2}$$

on an appropriate interval of convergence. Let $G(x) = \sin(x^2) f(x)$. Compute $G^{(4)}(0)$.

Answer: _____

Round: 1 2 3 4 5

2025 MAΘ National Convention Calculus Hustle: Problem #23

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2025 MAΘ National Convention Calculus Hustle: Problem #24

Find $x(-1)$, given the following differential equation.

$$\begin{cases} \dfrac{\mathrm{d}x}{\mathrm{d}t} = -7x \\ x(0) = 2025 \end{cases}$$

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Round: **1** **2** **3** **4** **5**

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2025 MAΘ National Convention
Calculus Hustle: Problem #25

Consider $f(x) = |1 - |1 - x| - |2 - x||$. Put $G(x) = e^{f(x)-2}$. Compute $G'(3)$

Answer: ________________

Round: 1 2 3 4 5

2025 MAΘ National Convention
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2025 MAΘ National Convention
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