

Mu Alpha Theta National Convention: 2007
Ciphering Test – Mu Division

Practice Round

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Practice. How many positive even integer solutions exist for the equation $a + b + c + d = 100$?

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Round 1

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1. A hemispherical bowl of radius 5 units is filled with water to a height of 2 units. How much more volume is needed to completely fill the bowl?

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Round 2

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2. Let $f(x) = x^x$. Find the sum of all values of x for which $f(x) = f'(x)$.

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Round 3

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3. If $f(x) = x^3 + ax^2 + bx + c$, find the product abc given that $f(x)$ has critical points at $x = -1$ and $x = 5$, and that $f(-1) = 9$.

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Round 4

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4. If $f(x)$ is a differentiable and concave down quadratic polynomial on the interval $[0,10]$, and if $f(x) < 0$ on $[0,10]$ with a relative maximum at $x = 2$, put the letters representing these approximations in order from smallest to largest.

$$A - \int_0^{10} f(x) dx$$

B – Left Hand Approximation of A using 10 rectangles of equal base length.

C – Right Hand Approximation of A using 10 rectangles of equal base length.

D – Midpoint Approximation of A using 10 rectangles of equal base length.

E – Trapezoid Approximation of A using 10 intervals of equal base length.

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Round 5

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5. Let A be the volume of the solid formed by rotating $y = 4 - x$ around the x -axis on the interval $x = 0$ to $x = 2$. Let B be the volume of the solid formed by the region bound by $x = 2$, $y = 4 - x$, and $y = k$, about the x -axis, where $k > 4$. For what exact value of k is $A = B$?

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5. Let A be the volume of the solid formed by rotating $y = 4 - x$ around the x -axis on the interval $x = 0$ to $x = 2$. Let B be the volume of the solid formed by the region bound by $x = 2$, $y = 4 - x$, and $y = k$, about the x -axis, where $k > 4$. For what exact value of k is $A = B$?

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Round 6

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6. A sphere of radius $\pi/2$ has a volume charge density of $p(r) = \frac{\sin(r)}{r}$. What is the total charge (Q) enclosed in the sphere? (Hint: $dQ = p \cdot dV$)

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6. A sphere of radius $\pi/2$ has a volume charge density of $p(r) = \frac{\sin(r)}{r}$. What is the total charge (Q) enclosed in the sphere? (Hint: $dQ = p \cdot dV$)

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Round 7

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7. An ellipse with a horizontal major axis of 6 and a vertical minor axis of 4 is revolved about its horizontal axis to form an ellipsoid. At time $t = 0$, a plane begins to pass through the ellipse perpendicular to its horizontal axis at a rate of 1 unit/sec. When $t = 4$ sec, at what rate is the cross-sectional area of the plane changing?

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7. An ellipse with a horizontal major axis of 6 and a vertical minor axis of 4 is revolved about its horizontal axis to form an ellipsoid. At time $t = 0$, a plane begins to pass through the ellipse perpendicular to its horizontal axis at a rate of 1 unit/sec. When $t = 4$ sec, at what rate is the cross-sectional area of the plane changing?

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Round 8

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8. Given $f(x) = x^3 - 2x - 4$ and $f^{-1}(x) = g(x)$ what is $g'(0)$?

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Round 9

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9. Let

$$A = \int_{-\infty}^{\infty} e^{-x^2} dx$$

$B =$ The area of a regular n -gon whose distance from the center to a vertex is 1 unit as $n \rightarrow \infty$.

What is A^{2B} (simplified)?

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Round 10

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10. Evaluate: $\int_{-1}^1 \frac{7x^{316} \sin(x^{325}) + 2x^{110} + x^{332}}{1 + x^{222}} dx$

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Extra Round

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Extra. Evaluate: $\lim_{n \rightarrow \infty} \sum_{k=1}^n \frac{n}{k^2 + n^2}$

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