1. If $Q(x) = \int_{\frac{x}{2}}^{-1} \cot^{-1} t \, dt$ then find $Q'(-2)$

(A) $\frac{-3\pi}{2}$ (B) $\frac{-3\pi}{4}$ (C) $\frac{-3\pi}{8}$ (D) $\frac{3\pi}{4}$ (E) $\frac{3\pi}{2}$

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2. Evaluate $\lim_{h \to 0} \frac{\int_2^{2+h} \sqrt{x^3 + 8}\, dx}{h}$

(A) 1 (B) $\frac{3}{2}$ (C) $\sqrt{10}$ (D) 4 (E) Does Not Exist

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3. Which of the following is a critical value for the function $f(x) = (3x - 2)^4 (2x + 1)^3$? This would be a root, or zero, from the first derivative.

(A) $x = \frac{-2}{3}$ (B) $x = \frac{-2}{17}$ (C) $x = 0$ (D) $x = \frac{1}{17}$ (E) $x = \frac{2}{17}$

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4. Find the average value of $f(x) = \left|1 - \frac{1}{2}x\right|$ on the interval $[-2, 6]$

(A) 1 (B) $\frac{4}{3}$ (C) $\frac{3}{2}$ (D) 2 (E) 4

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5. Suppose $f(x) = \sqrt{16 - x^2}$ for the domain of $[-4, 0]$. For the inverse of this function, $f^{-1}(x)$, find $\frac{d}{dx}\left(f^{-1}(x)\right)$

(A) $\frac{-1}{\sqrt{16 - x^2}}$ (B) $\frac{-1}{2\sqrt{16 - x^2}}$ (C) $\frac{-x}{\sqrt{16 - x^2}}$ (D) $\frac{\pm x}{\sqrt{16 - x^2}}$ (E) $\frac{x}{\sqrt{16 - x^2}}$

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6. Find the area bounded by the curves $x = |y|$ and $x = y^2$

(A) $\frac{1}{12}$ (B) $\frac{1}{6}$ (C) $\frac{1}{4}$ (D) $\frac{1}{3}$ (E) $\frac{2}{3}$

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7. If $\int_0^2 x\, e^{(k + x^2)}\, dx = \frac{e^4 - 1}{2e}$ then $k =$

(A) -1 (B) $\frac{-1}{2}$ (C) 0 (D) $\frac{1}{2}$ (E) 1

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8. Let $y = f(x)$ be the solution to the differential equation $\frac{dy}{dx} = x + y$ with the initial condition $f(1) = 2$. What is the approximation for $f(2)$ if Euler's Method is used, starting at $x = 1$ with a step size of $\frac{1}{2}$?

(A) 3 (B) 5 (C) 6 (D) 10 (E) 12

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9. The function $f(x)$ is continuous and differentiable on the closed interval $[0, 4]$. The table below gives selected values of $f(x)$ on this interval. Which of the following statements must be true?

x	0	1	2	3	4
f(x)	2	3	4	3	2

(A) The minimum value of $f(x)$ on $[0, 4]$ is 2.
(B) The maximum value of $f(x)$ on $[0, 4]$ is 4.
(C) $f(x) > 0$ for $0 < x < 4$
(D) $f'(x) < 0$ for $2 < x < 4$
(E) There exists a value c, with $0 < c < 4$, for which $f'(c) = 0$

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10. Find the equation of the normal line to the curve $x^3 - y^3 = 2xy$ at the point $(-1, 1)$.

(A) $y = -2x - 1$ (B) $y = -x$ (C) $y = \frac{-1}{2}x + \frac{1}{2}$ (D) $y = 1$ (E) $y = x + 2$

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11. The positive number that exceeds (is greater than) its cube by the greatest amount is

(A) $\frac{1}{2}$ (B) $\frac{1}{3}$ (C) $\frac{1}{4}$ (D) $\frac{\sqrt{2}}{2}$ (E) $\frac{\sqrt{3}}{3}$

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12. $$\int_{-4}^{4} \sqrt{16 - x^2}\, dx =$$

(A) $\frac{45}{2}$ (B) 23   (C) 26   (D) 27   (E) None of these

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13. Evaluate $$\int_{\frac{\pi}{6}}^{\frac{\pi}{3}} \frac{1 + \cos x}{\sin^2 x}\, dx$$

(A) 1   (B) $\sqrt{3}$ (C) 2   (D) $1 + \sqrt{3}$ (E) $2 + \sqrt{3}$

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14. $v(t) = t^3 - 6t^2 + 9t - 3$ represents the velocity of a particle on the interval $[1, 4]$. Find the value of t where the particle attains its maximum speed on the given interval.

(A) 1   (B) 2   (C) 3   (D) 4   (E) 1 and 4

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15. If $\int_a^b \frac{g'(t)}{g(t)}\, dt = \ln(g(b))$ then $g(a) =$

(A) 0   (B) $\frac{1}{e}$ (C) $\frac{1}{2e}$ (D) 1   (E) Cannot be determined

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16. If $f(x) = x^2 - 5x + 3$, then there exists a number c on the interval $(-2, 4)$ that satisfies the Mean Value Theorem, and the value is $c =$

(A) -1 (B) 0   (C) $\frac{1}{2}$ (D) $\frac{3}{4}$ (E) 1

17. A 15 foot ladder leans against a building so that its base moves away from the building at the rate of $4\ \frac{\text{ft}}{\text{sec}}$. When the base of the ladder is 12 feet from the building, the top of the ladder is moving down the wall at the rate of $d\ \frac{\text{ft}}{\text{sec}}$, where d is

(A) $\frac{4}{3}$ (B) $\frac{8}{3}$ (C) $\frac{12}{3}$ (D) $\frac{16}{3}$ (E) $\frac{20}{3}$

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18. The equations $x = 4 + 3\cos t$ and $y = -3 - 4\sin t$ describe a curve parametrically. Find the slope of the tangent line that passes through the point at $t = \frac{-\pi}{6}$

(A) $\frac{-4\sqrt{3}}{3}$ (B) $\frac{-2\sqrt{3}}{3}$ (C) $\frac{-\sqrt{3}}{3}$ (D) $\frac{2\sqrt{3}}{3}$ (E) $\frac{4\sqrt{3}}{3}$

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19. Evaluate $\lim_{x \to 8} \frac{\log_4(2x) - 2}{x - 8}$

(A) $\frac{1}{16 \ln 4}$ (B) $\frac{1}{8 \ln 4}$ (C) $\frac{1}{4 \ln 4}$ (D) $\frac{1}{2 \ln 4}$ (E) $\frac{1}{\ln 4}$

---

20. For values of h very close to 0, which of the following functions best approximates

$$f(x) = \frac{\sec(2x + 2h) - \sec(2x)}{2h} \text{ ?}$$

(A) $\frac{1}{2}\sec 2x\ \tan 2x$ (B) $\sec 2x \tan 2x$ (C) $\frac{\sec x}{h}$ (D) $\frac{\sec 2x}{h}$ (E) $2\sec 2x \tan 2x$

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21. Considering the table below for $f(x)$, find the best approximation for $f''(-2)$.

x	−4	−3	−2	−1	0	1
f (x)	1	3	7	14	22	35

(A) 2 (B) $\frac{5}{2}$ (C) $\frac{5}{3}$ (D) 3 (E) 4

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22. Evaluate $\int_{\frac{\pi}{2}}^{\frac{3\pi}{4}} (\csc^2 x - \cot^2 x)\, dx$

(A) 0 (B) $\frac{\pi}{6}$ (C) $\frac{\pi}{4}$ (D) $\frac{\pi}{3}$ (E) $\frac{\pi}{2}$

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23. The consumption of tomatoes in the United States is modeled by the continuous function $T(m)$ where T is measured in Tomatoes/month and m is measured in months. What are the units of $\int_0^{12} T(m)\, dm$?

(A) months (B) Tomatoes (C) $\frac{\text{months}}{\text{Tomato}}$ (D) $\frac{\text{Tomatoes}}{\text{month}}$ (E) Tomatoes x months

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24. Consider the function $f(x) = x^3 + ax^2 + bx$. Find a and b such that there is a local maximum at $x = -4$, a local minimum at $x = 0$, and a point of inflection at $x = -2$.

(A) $a = 6,\ b = 2$ (B) $a = 4,\ b = 0$ (C) $a = 6,\ b = 4$ (D) $a = 4,\ b = 2$ (E) $a = 6,\ b = 0$

25. Find an antiderivative of $e^{x + e^x}$

(A) $\dfrac{e^{x+e^x}}{1+e^x}$ (B) $(1 + e^x)e^{x+e^x}$ (C) e^{1+e^x} (D) e^{x+e^x} (E) e^{e^x}

26. Evaluate $D_x \ln\left(\dfrac{1}{1-2x}\right)$

(A) $\dfrac{2}{1-2x}$ (B) $\dfrac{2}{2x-1}$ (C) $\dfrac{1}{1-2x}$ (D) $\dfrac{1}{2x-1}$ (E) $2x - 1$

27. Consider a function $f(x)$, where $f(x) > 0$ on $[a, b]$, $f'(x) < 0$ on $[a, b]$, and $f''(x) < 0$ on $[a, b]$ If the interval $[a, b]$ is split into 4 equal subdivisions, and L is the left – hand Riemann sum for the partitioning, R is the right – hand Riemann sum for the partitioning, T is the trapezoidal approximation for the partitioning, and A is the area under the curve, then

(A) $R < A < T < L$ (B) $L < A < T < R$ (C) $L < T < A < R$
(D) $R < T < A < L$ (E) $T < R < A < L$

28. If the position of a particle is given by the function $s(t) = 2t^3 - 3t^2 + 5$ on the interval $[1, 4]$, then find the average acceleration of the particle on the given interval.

(A) 4 (B) 9 (C) 12 (D) 24 (E) 27

29. Let $h(x)$ be the function defined by $h(x) = f(g(x))$ where $f(x) = \sqrt{x}$ and $g(x) = \sec^{-1} x$, then find $h'(2)$

(A) $\dfrac{1}{4\sqrt{\pi}}$ (B) $\dfrac{1}{4\pi}$ (C) $\dfrac{1}{2\pi}$ (D) $\dfrac{\sqrt{\pi}}{12}$ (E) $\dfrac{\pi}{12}$

30. If the function f is given by $f(x) = \begin{cases} \sqrt{16 - 3x}, & 0 < x < 4 \\ \dfrac{-3}{32}x^2 + \dfrac{7}{2}, & x \geq 4 \end{cases}$ then find $f'(4)$

(A) $\dfrac{-3}{2}$ (B) $\dfrac{-3}{4}$ (C) $\dfrac{1}{4}$ (D) 2 (E) Does Not Exist