1. An equation of the tangent line to the curve \( y = \frac{1}{x^3} \) when \( x = -1 \) is given by

(a) \( y = -3x - 4 \)

(b) \( y = -2x - 3 \)

(c) \( y = -\frac{1}{3}x - \frac{4}{3} \)

(d) \( y = \frac{1}{3}x + 1 \)

(e) \( y = -3x - 2 \)

2. Let \( \mu \) be a real number not equal to \(-1\). Then \( \lim_{x \to 1} \frac{x^\mu}{x - 1} - 1 = \)

(a) \( \frac{\mu}{\mu + 1} \)

(b) \( \frac{\mu + 1}{\mu} \)

(c) \( \frac{1}{\mu + 1} \)

(d) \( \mu + 1 \)

(e) does not exist
3. \[ \sum_{k=1}^{7} (2k + 6k^2) = \]

(a) (16)(7)(8)
(b) (15)(7)(8)
(c) (16)(7)
(d) (7)(8)(10)
(e) (7)(8)(14)

4. Using four rectangles and the \textbf{midpoint rule}, the area under the graph of \( f(x) = 1 + x^2 \) from \( x = 0 \) to \( x = 4 \) is approximately equal to

(a) 25
(b) 20
(c) 30
(d) 27
(e) 18
5. Suppose that \( g(x) \leq f(x) \leq h(x) \) for all \( x \neq 2 \) and suppose that

\[
\lim_{x \to 2} g(x) = \lim_{x \to 2} h(x) = -5.
\]

Which one of the following statements is \textbf{TRUE}:

(a) \( \lim_{x \to 2} f(x) \neq 0 \)

(b) \( f(2) \) must be equal to \(-5\)

(c) \( f(2) \) cannot be equal to \(0\)

(d) \( \lim_{x \to 2} f(x) \) can be different from \(-5\)

(e) \( f(2) \) and \( \lim_{x \to 2} f(x) \) must be equal

6. If \( f(x) = \frac{x^3 + 2x^2 - 1}{(x + 1)^2} \), then an equation of the oblique asymptote for the graph of \( f \) is

(a) \( y - x = 0 \)

(b) \( y - x - 1 = 0 \)

(c) \( y + x = 0 \)

(d) \( y + x + 1 = 0 \)

(e) \( f \) does not have an oblique asymptote
7. If \( f(x) = \cot^{-1}\left( \frac{1}{x} \right) - \tan^{-1} x \), then \( f'(1) = \)

(a) \( f'(2) \)

(b) does not exist

(c) \(-1\)

(d) \(-\frac{2}{3}\)

(e) \( f'(0) \)

8. If \( y = (\sec x + \tan x)(\sec x - \tan x) \), then \( \frac{dy}{dx} = \)

(a) 0

(b) \( \sec^2 x \)

(c) \( \sec^3 x \)

(d) 1

(e) \( \sec^2 x \tan x \)
9. The slope of the normal line to the curve \(2y + \pi \sin(xy) = 2\pi\) at the point \((1, \pi)\) is

(a) \(\frac{\pi - 2}{\pi^2}\)

(b) 0

(c) \(\frac{1}{\pi}\)

(d) \(-\frac{2}{\pi^2}\)

(e) None of them

10. Newton’s method is used to estimate the \(x\)-coordinate of the point of intersection of the curves \(y = \sqrt{x}\) and \(y = 1 - x^2\). If we start with \(x_0 = 1\), then \(x_1 =\)

(a) \(\frac{3}{5}\)

(b) 0

(c) \(-\frac{1}{2}\)

(d) \(\frac{1}{2}\)

(e) \(\frac{8}{5}\)
11. If the function

\[ f(x) = \begin{cases} 
  x + b & x < 0 \\
  b + 1 & x \geq 0 \\
  x^2 + b & x \geq 0 
\end{cases} \]

is continuous everywhere, then \( f(-1) = \)

(a) \(-1\)
(b) \(0\)
(c) \(2\)
(d) \(4\)
(e) \(-3\)

12. Let \( f(x) = \sqrt{1 - 3x} \). The greatest possible value of \( \delta > 0 \) for which \( \lim_{x \to -1} f(x) = 2 \), when \( \varepsilon = \frac{1}{2} \) is

(a) \( \frac{7}{12} \)
(b) \( \frac{9}{12} \)
(c) \( \frac{5}{12} \)
(d) \( \frac{5}{2} \)
(e) \( \frac{3}{2} \)
13. Evaluate the limit \( \lim_{x \to -\infty} (x + \sqrt{x^2 + 2x}) \)

(a) \(-1\)
(b) \(1\)
(c) \(-2\)
(d) \(2\)
(e) \(0\)

14. If \( y = (2x)^{\sin(2x)} \), \( \frac{dy}{dx} = \)

(a) \( y \left[ \frac{\sin(2x)}{x} + 2 \ln(2x) \cos(2x) \right] \)
(b) \( y \left[ \frac{\sin(2x)}{2x} + 2 \ln(2x) \cos(2x) \right] \)
(c) \( y \left[ \frac{\sin(2x)}{x} - 2 \ln(2x) \cos(2x) \right] \)
(d) \( \sin(2x) (2x)^{\sin(2x)-1} \ln(2x) \)
(e) \( y \left[ \frac{\cos(2x)}{x} - 2 \ln(2x) \sin(2x) \right] \)
15. Evaluate the limit \( \lim_{x \to -1^+} (\sqrt{x+1} \ln(x+1)) \)

(a) 0
(b) 1
(c) −1
(d) \(\infty\)
(e) \(−\infty\)

16. Let \( f(x) = \cos^2 x + \sin x, \) \( 0 < x < \pi. \) Which one of the following statements is TRUE:

(a) \( f \) is decreasing on the intervals \( \left(\frac{\pi}{6}, \frac{\pi}{2}\right) \) and \( \left(\frac{5\pi}{6}, \pi\right) \)
(b) \( f \) is decreasing on the interval \( \left(\frac{\pi}{6}, \frac{5\pi}{6}\right) \)
(c) \( f \) is increasing on the interval \( \left(\frac{\pi}{3}, \frac{2\pi}{3}\right) \)
(d) \( f \) is increasing on the intervals \( \left(0, \frac{\pi}{3}\right) \) and \( \left(\frac{\pi}{2}, \frac{2\pi}{3}\right) \)
(e) \( f \) is decreasing on the intervals \( \left(\frac{\pi}{6}, \frac{\pi}{2}\right) \) and \( \left(\frac{2\pi}{3}, \pi\right) \)
17. If \( F(x) = f(xf(xf(x))) \) where \( f(1) = 2, f(2) = 3, f'(1) = 4, f'(2) = 5 \) and \( f'(3) = 6 \), then \( F'(1) = \)

(a) 198  
(b) 0  
(c) \(-1\)  
(d) \(-200\)  
(e) 144

18. Let \( f(x) = \frac{2x^2}{x^2 - 1} \). Which one of the following statements is TRUE:

(a) The graph of \( f \) is concave up on \((-\infty, -1) \cup (1, \infty)\)

(b) The graph of \( f \) is concave up on \((-\infty, -1) \cup (0, 1)\)

(c) The graph of \( f \) is concave down on \((-1, 1) \cup (1, \infty)\)

(d) The graph of \( f \) is concave down on \((-1, 0) \cup (1, \infty)\)

(e) \( f \) has two inflection points
19. Let \( f(x) = x^2 \sqrt{5 - \frac{x}{2}}, x \in [-2, 2] \). Which one of the following statements is **TRUE**?

(a) \( f \) has a local minimum at \( x = 0 \)

(b) \( f \) has a local maximum at \( x = 8 \)

(c) the absolute maximum value of \( f \) is 8

(d) \( f \) has absolute minimum at \( x = -2 \)

(e) \( f \) has no absolute minimum

20. The most general antiderivative of \( f(t) = \frac{te^{2t} + \sqrt{t}}{t} \) is

(a) \( \frac{1}{2}e^{2t} + 3t^{1/3} + C \)

(b) \( e^{2t} + 3t^{2/3} + C \)

(c) \( te^{2t} + t^{-2/3} + C \)

(d) \( 2e^{2t} - \frac{3}{2}t^{-5/3} + C \)

(e) \( \frac{1}{2}e^{2t} - \frac{3}{2}t^{-5/3} + C \)
21. The **number** of the critical points of \( f(x) = |x^3 - 4x| \) is

(a) 5
(b) 4
(c) 3
(d) 2
(e) 1

22. The real values of \( x_0 \) and \( L \) that satisfy the following limit

\[
\lim_{x \to x_0} \frac{\ln(x + 1)}{x - x_0} = 3L
\]

are

(a) \( x_0 = 0; \ L = \frac{1}{3} \)
(b) \( x_0 = -1; \ L = \frac{1}{2} \)
(c) \( x_0 = -2; \ L = 1 \)
(d) \( x_0 = 1; \ L = \frac{1}{3} \)
(e) \( x_0 = \frac{1}{3}; \ L = \frac{1}{4} \)
23. Approximating \( \tan^{-1}(1.01) \) using a linearization of 
\( f(x) = \tan^{-1}(x) \) at a suitably chosen integer near 1.01 is equal to

(a) \( \frac{\pi}{4} + 0.005 \)

(b) \( \frac{\pi}{2} + 0.005 \)

(c) \( \frac{\pi}{4} + 0.01 \)

(d) \( \frac{\pi}{2} + 0.01 \)

(e) 0.005

24. The value(s) of \( c \) satisfying the conclusion of the Mean Value Theorem for the function \( f(x) = x + \frac{1}{x} \), on the interval \( \left[ \frac{1}{2}, 2 \right] \) is (are)

(a) 1

(b) \(-1 \text{ and } 1\)

(c) \( \frac{1}{2} \text{ and } \frac{3}{2} \)

(d) \( \frac{1}{4} \text{ and } 1 \)

(e) 1 and \( \frac{7}{4} \)
25. Let $a > 0$ and let $f(x) = \frac{x^2}{3} + \frac{x}{a}, a \leq x \leq 2a$. The value of $a$ such that the \textbf{average rate of change} of the function $f$ on the interval $[a, 2a]$ is the \textbf{smallest possible} is

(a) 1
(b) $\frac{1}{\sqrt{2}}$
(c) $\sqrt{2}$
(d) 2
(e) $\sqrt{3}$

26. A surveyor, standing 50 ft from the base of a building, measures the angle of elevation to the top of the building to be $45^\circ$. How accurately must the angle be measured for the percentage error in estimating the height of the building to be less than 3%?

(a) 1.5%
(b) 1%
(c) 2%
(d) 2.5%
(e) 3%
27. The volume of a cube is increasing at the rate of $270 \text{ cm}^3/\text{min}$ at the instant its edges are 6 cm long. At the same instant, the rate at which the lengths of the edges is changing is equal to

(a) $2.5 \text{ cm/min}$
(b) $3 \text{ cm/min}$
(c) $3.5 \text{ cm/min}$
(d) $2 \text{ cm/min}$
(e) $4 \text{ cm/min}$

28. The least amount of material needed to construct an open-top right circular can that will hold a volume of $1000 \text{ cm}^3$ is equal to

(a) $300\pi^{1/3} \text{ cm}^2$
(b) $100\pi^{-2/3} \text{ cm}^2$
(c) $10\pi^{-1/3} \text{ cm}^2$
(d) $400\pi^{1/3} \text{ cm}^2$
(e) $300\pi^{-2/3} \text{ cm}^2$
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