1. If \( y = x^2 \sin x + 2x \cos x - 2 \sin x \), then \( y' = \)

(a) \( x^2 \cos x \)

(b) \( x^2 \cos x - 4x \sin x - 4x \cos x \)

(c) \( (x^2 + x + 1) \cos x \)

(d) \( x^2 \sin x \)

(e) \( x^2 \cos x - 4 \cos x \)

2. The accompanying figure shows the graph of \( y = f(x) \). Then the graph of \( y = f'(x) \) lies below the \( x \)-axis on the interval(s)

(a) \( (-\infty, -1) \) and \( (0, 1) \)

(b) \( (-2, 2) \)

(c) \( (-1, 0) \) and \( (1, \infty) \)

(d) \( (-1, 1) \)

(e) \( (-\infty, -2) \) and \( (2, \infty) \)
3. If $-1 < x < 0$, then $\frac{d}{dx} \cos^{-1} \sqrt{1 - x^2} =$

(a) $\frac{-1}{\sqrt{1 - x^2}}$
(b) $\frac{-2x}{\sqrt{1 - x^2}}$
(c) $\frac{2}{\sqrt{1 - x^2}}$
(d) $\frac{1}{x\sqrt{1 - x^2}}$
(e) $\frac{-1}{x\sqrt{1 - x^2}}$

4. Let $x$ and $y$ be differentiable functions of $t$.
If $x^2 y^3 = \frac{8}{27}$ and $\frac{dy}{dt} = \frac{1}{2}$, then $\frac{dx}{dt}$ when $x = 1$ is equal to

(a) $-\frac{9}{8}$
(b) $\frac{4}{27}$
(c) $-\frac{3}{8}$
(d) $-\frac{2}{27}$
(e) $\frac{4}{9}$
5. If \( f(x) = \ln(x^2 + 4)^{-3} - 3x \cot^{-1}\left(\frac{x}{2}\right) \), then \( f'(-2) = \)

(a) \( \frac{3\pi}{4} \)

(b) \( -\frac{6}{5} + \frac{3\pi}{4} \)

(c) \( -3 + \frac{3\pi}{4} \)

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

(e) \( \frac{1}{2} + \frac{3\pi}{4} \)

6. If \( \lim_{h \to 0} \frac{f(-4 + h) - f(-4)}{h} = 3 \), then which one of the following statements is \textbf{FALSE}?

(a) \( \lim_{x \to -4} f(x) \) does not exist

(b) The function \( f \) is continuous at \( x = -4 \)

(c) The rate of change of \( f(x) \) with respect to \( x \) at \( x = -4 \) is 3

(d) The function \( f \) is differentiable at \( x = -4 \)

(e) The slope of the tangent line to \( f \) at \( x = -4 \) is 3
7. If the function \( f(x) = \begin{cases} \ ax + b, & x > -1 \\ \ bx^2 - 1, & x \leq -1 \end{cases} \) is differentiable everywhere, then \( 8a + 6b = \)

(a) 5
(b) -2
(c) 9
(d) -1
(e) 11

8. If at time \( t \), the position of a body moving along the \( s \)-axis is \( s(t) = t^3 - 9t^2 + 24t \), then the total distance traveled by the body from \( t = 0 \) to \( t = 3 \) is

(a) 22
(b) 20
(c) 54
(d) 64
(e) 18
9. If \( f(x) = x^{4/3} \), then which one of the following statements is **FALSE**?

(a) \( f \) is not differentiable at \( x = 0 \).

(b) \( f'(8) = \frac{8}{3} \)

(c) \( f \) has a horizontal tangent at \( x = 0 \).

(d) \( f \) has no vertical tangent at \( x = 0 \)

(e) \( \lim_{x \to 0^-} f(x) = 0 \)

10. If \( f(t) = t^2(t^3 - 1)^5 \), then \( f'(t) = \\

(a) \( t (t^3 - 1)^4 (17t^3 - 2) \)

(b) \( 2t (t^3 - 1)^4 (15t^3 - 4) \)

(c) \( t (t^3 - 1)^4 (17t^3 - 3) \)

(d) \( 15 (t^3 - 1)^4 (17t^3 - 2) \)

(e) \( t (t^3 - 1)^5 (17t^3 - 1) \)
11. The rate of change of \( s(t) = \left(e^{\tan 2t}\right)^3 \) with respect to \( t \) at \( t = \frac{\pi}{8} \) is

(a) \( 12e^3 \)
(b) \( 18e^2 \)
(c) \( 6e^3 \)
(d) \( 6e^2 \)
(e) \( 3e^3 \)

12. A table of values of \( f, g, f', \) and \( g' \) is given, if \( H(x) = e^x g(f(x)) \), then \( H'(0) = \)

(a) 25
(b) 17
(c) 40
(d) 3
(e) 29
13. If \( y^3 + 3x = 1 - 3y \), then the product \((y^2 + 1)^3 y''\) is equal to

(a) \(-2y\)

(b) 1

(c) \(-3y\)

(d) \(y\)

(e) \(-y\)

14. The sum of all values of \(x\) at which the tangent lines to the graph of \(y = \frac{x - 1}{x + 1}\) are parallel to the line \(9x - 2y + 1 = 0\) is

(a) \(-2\)

(b) 1

(c) \(-3\)

(d) \(-2/3\)

(e) \(4/3\)
15. If \( y = \frac{2x - 1}{3x + 1} \), then \( y''' \) is equal to

(a) \( 270 (3x + 1)^{-4} \)
(b) \( -150 (3x + 1)^{-4} \)
(c) \( -270 (3x + 1)^{-3} \)
(d) \( 150 (3x + 1)^{-4} \)
(e) \( -90 (3x + 1)^{-3} \)

16. The slope of the tangent line to the graph of
\[
y = \frac{(3x^2 + 1)^{3/2}(5x - 1)^{1/2}}{(x^3 + 7)^{1/3}}
\]
at \( x = 1 \), is [Hint: You may use logarithmic differentiation]

(a) 22
(b) 24
(c) 18
(d) 28
(e) 30
17. When sketching the graph of \( f(x) = 2 - |3 - x| \) we find that only one of the following statements is TRUE

(a) The left-hand derivative of \( f \) at 3 is 1
(b) The right-hand derivative of \( f \) at 5 is 0
(c) The left-hand derivative of \( f \) at 0 is \(-1\)
(d) \( f'(3) = \pm 1 \)
(e) \( f'(0) = f'(5) \)

18. A hot air balloon rising straight up from a level field is tracked by a boy 300 ft on the ground from the lifting point. If the balloon is rising at the constant rate of 150 ft/min, then the rate of change of the boy’s elevation angle \( \theta \) when \( \theta = \frac{\pi}{4} \) is

(a) 0.25 rad/min
(b) 0.125 rad/min
(c) 0.025 rad/min
(d) 0.0125 rad/min
(e) 0.075 rad/min
19. If $y = x^{x - \ln x}$, then $\frac{xy'}{y}$ is equal to

(a) $x - 2 \ln x + x \ln x$
(b) $x - \ln x + 2x \ln x$
(c) $2x - \ln x + x \ln x$
(d) $x + 2 \ln x - 2x \ln x$
(e) $-2x + \ln x - x \ln x$

20. The slope of the normal line to the curve $2x^2 \sin^2 y + 3\sqrt{2} \cos y = 4$ at the point $(1, \frac{\pi}{4})$ is

(a) $-1/2$
(b) $2/3$
(c) $-1/3$
(d) $3/2$
(e) $-1/4$