1. A ball is thrown in the air with position (at t seconds) given by \( s(t) = 2t^3 + t^2 \). Let \( v_a \) be the average velocity from time \( t=1 \) to time \( t=3 \) and \( v_i \) be the instantaneous velocity at time \( t=3 \). Then

(A) \( v_a = 30, v_i = 60 \)
(B) \( v_a = 33, v_i = 63 \)
(C) \( v_a = 48, v_i = 60 \)
(D) \( v_a = 48, v_i = 63 \)
(E) \( v_a = 120, v_i = 60 \)

2. If \( f \) is a differentiable function with \( f(4) = 1 \) and \( f'(4) = 2 \), the derivative of \( \frac{1 + e^x f(x)}{\sqrt{x}} \) at \( x=4 \) is:

(A) \( 12e^4 \)
(B) \( \frac{3e^4}{4} \)
(C) \( \frac{23e^4 + 1}{16} \)
(D) \( \frac{23e^4 - 1}{16} \)
(E) \( \frac{6e^4 - 1}{4} \)
3. If $g(x) = x + 2 \cos x$, find all values of $a$ in $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ at which the tangent line through $(a, g(a))$ is parallel to $y = 2x - 3$.

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

4. Find $\frac{dy}{dx}$ at $x = \frac{\pi}{2}$ for $y = e^{\sin 2t}$.

(A) 2
(B) -2
(C) 0
(D) $e$
(E) $-e$

5. The tangent line to $h(t) = (2t - \frac{1}{t})^{3/2}$ at the point $(1,1)$ is:

(A) $y - 1 = -\frac{2}{9}(x - 1)$
(B) $y - 1 = \frac{9}{2}(x - 1)$
(C) $y - 1 = \frac{3}{2}(x - 1)$
(D) $y - 1 = \frac{2}{9}(x - 1)$
(E) $y - 1 = 3(x - 1)$
6. Find \( g'(t) \) if \( g(t) = \sin^{-1}\left(\frac{2}{t}\right) \).

(A) \( \frac{-1}{\sqrt{t^2-4}} \)

(B) \( \frac{2}{\sqrt{t^2-4}} \)

(C) \( \frac{1}{\sqrt{t^2-4}} \)

(D) \( \frac{-2}{t\sqrt{t^2-4}} \)

(E) \( \frac{2}{t\sqrt{t^2-4}} \)

7. If \( f(x) \) is as sketched, which graph represents the graph of \( f' \)?
8. Find \( \lim_{\theta \to 0} \left( \frac{\cos \theta - 1}{\theta \sin \theta} \right) \).

(A) -2
(B) -1
(C) -\( \frac{1}{2} \)
(D) 0
(E) The limit does not exist

9. Compute \( \frac{d}{dx} (3x^2) \) when \( x = 2 \):

(A) 9 \ln 3
(B) 81 \ln 3
(C) 36 \ln 3
(D) 324 \ln 3
(E) \( \frac{81}{\ln 3} \)

10. Assume \( f \) and \( g \) are differentiable functions, \( F(x) = f(g(x)) \), \( g(1) = 2 \), \( f(1) = -1 \), \( f(2) = 3 \), \( g'(1) = 10 \), \( f'(1) = 5 \), and \( f'(2) = 4 \). Compute \( F'(1) \).

(A) -10
(B) -8
(C) 8
(D) 30
(E) 40
11. Find $\frac{dy}{dx}$ at the point $(0, \frac{x}{5})$ for the curve given implicitly by $\tan(x - y) = xe^x - 1$.

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

12. A particle moves on a line with equation of motion $s(t) = \sin \pi t$ for $0 < t < 1$. Find the acceleration at the instant when the velocity is zero.

(A) $\pi^2$
(B) $\pi$
(C) 1
(D) $-\pi$
(E) $-\pi^2$
13. Find a formula for \( f^{(3)}(-1) \) if \( f(x) = \frac{1}{3x^2+1} \).

   (A) \(-\frac{81}{8}\)
   (B) \(-\frac{9}{4}\)
   (C) \(-\frac{3}{64}\)
   (D) \(-\frac{1}{4}\)
   (E) 27

14. A cylinder of height 1 and radius \( r \) has value \( V = 2\pi r^2 \). If \( r \) is increasing at the rate of 3 cm./sec., how fast is the volume increasing when \( r = 2 \)?

   (A) 6\pi
   (B) 12\pi
   (C) 18\pi
   (D) 24\pi
   (E) 32\pi