1. \[ \lim_{{t \to 1}} \frac{50(t^2 + 4t)}{t^2 + 3t + 21} = \]
   (a) 10
   (b) \( \frac{1}{10} \)
   (c) 2
   (d) \( \frac{1}{50} \)
   (e) 50

   \[ \frac{50(1+4)}{1+3+21} = \frac{(50)(5)}{25} = 10 \]

2. \[ \lim_{{x \to 1}} \frac{2x^2 + x - 3}{x^2 + 4x - 5} = \]
   (a) \( \frac{5}{6} \)
   (b) \( \frac{1}{4} \)
   (c) \( \frac{3}{5} \)
   (d) 2
   (e) \( \frac{1}{2} \)

   \[ \lim_{{x \to 1}} \frac{(2x+3)(x-1)}{(x+5)(x-1)} = \frac{2(1)+3}{1+5} = \frac{5}{6} \]
3. Let \( f(x) = \frac{1}{2x + 3} \). Then 
\[
\lim_{h \to 0} \frac{f(h) - f(0)}{h} = \lim_{h \to 0} \frac{f(0+h) - f(0)}{h}
\]
\[
= f'(0)
\]
(a) \(-\frac{2}{9}\)  
(b) \(-\frac{1}{2}\)  
(c) \(\frac{1}{4}\)  
(d) 2  
(e) \(-\frac{2}{3}\)

4. \[
\lim_{x \to \infty} \frac{2x^2 - 4x^4 - 3}{x^2 - 3} = \lim_{x \to \infty} \frac{-4x^4}{x^2}
\]
\[
= \lim_{x \to \infty} -4x^2
\]
\[
= (-4)(\infty) = -\infty
\]
(a) \(-\infty\)  
(b) 2  
(c) \(\infty\)  
(d) \(-4\)  
(e) 0
5. \[
\lim_{x \to 2^-} \frac{4}{x - 2} = \lim_{u \to 0^-} \frac{4}{u} (u = x - 2)
\]
   (a) \(-\infty\)
   (b) 4
   (c) \(\infty\)
   (d) 0
   (e) \(-2\)

6. The set of the value(s) of \(x\) for which

   \[f(x) = \begin{cases} 
   \frac{1}{x}, & x > 1 \\
   3x - 4, & x < 1 
   \end{cases}\]

is discontinuous is:

   (a) \(\{1\}\)
   (b) \(\{0, 1\}\)
   (c) \(\{0\}\)
   (d) \(\{\}\)
   (e) \(\{-4\}\)

Note: \(f(1) = -4\)

\(\lim_{x \to 1^-} f(x) = \lim_{x \to 1^-} (3x - 4) = 3(1) - 4 = -1 \neq \lim_{x \to 1^+} f(x) = \lim_{x \to 1^+} \frac{1}{x} = 1\)

\(f(x)\) is not continuous at \(x = 1\).
7. The slope of the curve \( y = \frac{4}{2-x} \) at the point \((3, -4)\) is

(a) 4
(b) \(\frac{1}{4}\)
(c) \(-2\)
(d) \(-\frac{1}{2}\)
(e) 0

\[ m_{\text{tangent}} = y' \bigg|_{x=3} = \frac{4 \cdot (0)(-1)}{(2-3)^2} = \frac{-4}{1} = -4 \]

8. If \( f(x) = \frac{x^2 - 3x^{-2/3}}{x} \), then \( f'(x) = \)

(a) \(1 + 5x^{-8/3}\)
(b) \(2x + 2x^{-5/3}\)
(c) \(\frac{3x^2 + 2x^{-5/3} - 3x^{-3/2}}{x^2}\)
(d) \(\frac{2x + 2x^{-1}}{x^2}\)
(e) 0

\[ f'(x) = x - 3 \cdot \left( -\frac{5}{2} \right) x^{-\frac{5}{2}} = 1 + 5x^{-\frac{5}{2}} \]
9. An equation of the tangent line to the curve \( y = 4x^2 - 6x - 5 \) at the point \((-1, 5)\) is

- (a) \( y = -14x - 9 \)
- (b) \( y = 8x - 6 \)
- (c) \( y = (8x - 6)(x - 1) + 5 \)
- (d) \( y = 14x + 71 \)
- (e) \( y = -14x + 19 \)

\[
y' = 8x - 6.
\]

\[
y = 8(1) - 6 = 2.
\]

\[
x_{\text{near}} = y' = 8 \quad \text{at} \quad x = -1 = -14.
\]

\[
y - 5 = m(x - x_0)
\]

\[
y - 5 = -14(x - (-1))
\]

\[
y = -14x + 14 + 5
\]

\[
y = -14x - 9.
\]

10. The average cost \( \bar{c} \) for producing \( q \) units of a product is given by \( \bar{c} = 0.01q^2 + 11 + \frac{1000}{q} \). The marginal cost when \( q = 10 \) is

- (a) 14
- (b) 82.4
- (c) 12
- (d) 1120
- (e) 112

\[
c'(10) = (0.03)(10)^2 + 11
\]

\[
c'(10) = 3 + 11
\]

\[
c'(10) = 14
\]
11. If \( f(x) = \frac{x^2 - 1}{x^3 + x + 1} \), then \( f'(1) = \)

(a) \( \frac{2}{3} \)
(b) \( \frac{-1}{3} \)
(c) 1
(d) 2
(e) 0

Using the Quotient Rule:

\[ f'(x) = \frac{2x(x^3 + x + 1) - (3x^2 + 1)(x^2 - 1)}{(x^3 + x + 1)^2} \]

\[ f'(1) = \frac{2(3) - 0}{(3)^2} = \frac{6}{9} = \frac{2}{3} \]

12. Let \( f(x) = x^2 g(x) \). If \( g(1) = 2 \) and \( g'(1) = 2 \), then \( f''(1) = \)

(a) 6
(b) 4
(c) 2
(d) 1
(e) 0

\[ f'(x) = 2x \cdot g(x) + x^2 \cdot g'(x) \]

\[ f'(1) = 2 \cdot g(1) + 1 \cdot g'(1) = 2(2) + 2 = 6 \]
13. The cost $c$ of producing $q$ units of a product is given by

$$c = 5500 + 12q + 0.2q^2$$

and the price per unit $p$ is given by the equation

$$q = 900 - 1.5p.$$  

Using the chain rule, the rate of change of cost with respect to the price per unit when $p = 100$ is

(a) \(-468\)

(b) \(512\)

(c) \(-400\)

(d) \(320\)

(e) \(-424\)

Let $f(x) = (x + g(x))^3$. If $g(1) = 1$ and $g'(1) = -1$, then $f'(1) =$

(a) \(0\)

(b) \(3\)

(c) \(6\)

(d) \(2\)

(e) \(24\)
15. The slope of the tangent line of $y = \ln(x^2 - 3x - 3)$ at $x = 4$ is:

- (a) $5$
- (b) $-5$
- (c) $1$
- (d) $-1$
- (e) $0$

\[
y' = \frac{2x - 3}{x^2 - 3x - 3}
\]

At $x = 4$:
\[
y' = \left. \frac{2x - 3}{x^2 - 3x - 3} \right|_{x=4} = \frac{2(4) - 3}{16 - 12 - 3} = \frac{5}{1} = 5
\]

16. Let $f(x) = e^x + e^{3x} + 3^{-x}$. Then $f'(0) =$

- (a) $3 - \ln 3$
- (b) $3 + \ln 3$
- (c) $e^x + 3 - \ln 3$
- (d) $e^x + 3 + \ln 3$
- (e) $e + \ln 3$

\[
f'(x) = 0 + 3e^{3x} + 3^{-x} \cdot (\ln 3) (-1)
\]
\[
f'(0) = 0 + 3e^{3\cdot0} - (\ln 3) \cdot \frac{1}{3} = 3 - \ln 3
\]
17. After \( t \) years, the value \( S \) of a principal \( P \) dollars invested at the annual rate of \( r \) compounded continuously is given by \( S = Pe^{rt} \). The relative rate of change of \( S \) with respect to \( t \) is

\[
\frac{dS}{dt} = P e^{rt}
\]

(a) \( r \)
(b) \( Pr \)
(c) \( P \)
(d) \( 2r \)
(e) \( 2P \)

18. A country's savings \( S \) is defined implicitly in terms of its national income \( I \) by the equation

\[
S^2 + \frac{1}{4}I^2 = SI + I
\]

where both \( S \) and \( I \) are in billions of dollars. The marginal propensity to consume with \( I = 16 \) and \( S = 12 \) is

(a) \( \frac{3}{8} \)
(b) \( \frac{1}{2} \)
(c) \( \frac{5}{8} \)
(d) \( \frac{3}{4} \)
(e) \( \frac{7}{8} \)
19. If \( y = (2x - 1)^3x \), then \( y'(1) = \)

(a) \( 6 \)

\[
\ln y = 3x \ln (2x-1)
\]

\[
y' = 3 \cdot \frac{6x}{2x-1}
\]

(b) \( -6 \)

(c) \( 3 \ln (2) \)

(d) \( 6 \ln (3) \)

(e) \( 3 \)

At \( x=1 \), \( y = 1 \).

\[
y'_{x=1} = 3 \ln (4) + \frac{(3)(2)}{2}
\]

\[
= 0 + 6 = 6.
\]

20. If \( c = 0.2q^2 + 2q + 500 \) is a cost function, the rate of change of the marginal cost when \( q = 100 \) is

(a) \( 0.4 \)

\[
c'(q) = 0.4q + 2.
\]

(b) \( 0.04 \)

\[
c''(q) = 0.4.
\]

(c) \( 4 \)

\[
c'''(100) = 0.4.
\]

(d) \( 42 \)

(e) \( 40 \)
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