1. The point \( P(4, 2) \) lies on the curve \( y = \frac{x}{x - 2} \). If \( Q \) is the point \( \left( x, \frac{x}{x - 2} \right) \), then the slope of the secant line \( PQ \) when \( x = a \) is:

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

   (b) 0

   (c) 1

   (d) \( \frac{1}{a - 4} \)

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

2. If a rock is thrown upward on the planet Mars with a velocity of 10 m/s, its height in meters \( t \) seconds later is given by \( y = 10t - 1.86t^2 \). The instantaneous velocity when \( t = 1 \) is

   (a) 6.28 m/s

   (b) 5.28 m/s

   (c) 8.08 m/s

   (d) 0.27 m/s

   (e) 3.14 m/s
3. The point where the function $f(x) = \sqrt{x}$ has a vertical tangent line is

(a) $(0, 0)$

(b) $(1, 1)$

(c) $(-1, 0)$

(d) $(-1, -1)$

(e) $(0, 1)$

4. $\lim_{x \to -1} \left( |x| + \left\lfloor -\frac{x}{2} - \frac{3}{4} \right\rfloor \right)$

(where $[x]$ is the greatest integer less than or equal to $x$)

(a) equals 0

(b) equals −1

(c) equals 1

(d) equals −2

(e) does not exist
5. If \( f(x) = \frac{x^2 + 2x}{x^3 + x^2 - 2x} \), then

(a) \( f \) has a vertical asymptote at \( x = 1 \)

(b) \( \lim_{x \to -2^-} f(x) = -\infty \)

(c) \( \lim_{x \to -2^+} f(x) = -\infty \)

(d) \( f \) has a vertical asymptote at \( x = 0 \)

(e) \( f \) has a horizontal asymptote at \( y = 1 \) and \( y = 2 \)

6. Which of the following choices about the function \( y = f(x) \), graphed here, is true?

(a) \( \lim_{x \to x_0} f(x) \) exists at every point \( x_0 \) in \((-1, 1)\)

(b) \( \lim_{x \to 1} f(x) = -1 \)

(c) \( \lim_{x \to 0} f(x) \) does not exist

(d) \( \lim_{x \to 1} f(x) = 0 \)

(e) \( \lim_{x \to 0} f(x) = 1 \)
7. \[ \lim_{{x \to 0}} \sqrt{x^3 + x^2} \sin \frac{\pi}{x} \]

(a) equals 0  
(b) equals \(-1\)  
(c) equals 1  
(d) does not exist  
(e) equals \(\pi\)

8. \[ \lim_{{x \to 1^-}} \frac{[x]}{|x - 1|} = \]

(\text{where} \ [x] \ \text{is the greatest integer less than or equal to} \ x)

(a) 0  
(b) \(\infty\)  
(c) \(-\infty\)  
(d) \(-2\)  
(e) \(2\)
9. If $y = L$ is the horizontal asymptote for

$$f(x) = (e^{-x} \sin x + \frac{x}{1+x})$$

then $L$ is

(a) 1
(b) 0
(c) $-1$
(d) 2
(e) π

10. To satisfy the $\epsilon - \delta$ definition of the limit $\lim_{x \to 1}(3 - 4x) = -1$, the largest number $\delta$ that correspond to $\epsilon = 0.02$ is

(a) 0.005
(b) 0.05
(c) 0.004
(d) $-0.005$
(e) $-0.002$
11. If the statement “for every number \( \varepsilon > 0 \), there is a number \( \delta > 0 \) such that if \( |x + 2| < \delta \), then \( |f(x) - 3| < \varepsilon \)” is true, then select all that always applies.

(I) \( \lim_{x \to -2} f(x) = 3 \)

(II) \( \lim_{x \to 3} f(x) = -2 \)

(III) \( f(-2) = 3 \)

(IV) \( f(3) = -2 \)

(a) only (I)

(b) (I) and (III)

(c) (I) and (IV)

(d) (II) and (III)

(e) (II) and (IV)

12. The function

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

has

(a) one removable discontinuity and one infinite discontinuity

(b) only one discontinuity

(c) two infinite discontinuities

(d) two removable discontinuities

(e) two vertical asymptotes
13. If \( f(x) = \begin{cases} a, & x < 0 \\ \frac{\sqrt{4 - 3x} - 1}{x - 1}, & 0 \leq x < 1 \\ x + b, & x \geq 1 \end{cases} \) is continuous at every \( x \), then \( a + b \) is

(a) \( \frac{-7}{2} \)

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

(c) \( \frac{5}{2} \)

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

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

14. Let \( a \) and \( b \) be two non zero constants. Which one of the following conditions would guarantee that \( f(x) = ae^x - bx \) has a zero in the interval \([0, 1]\).

(a) \( a < 0, \frac{b}{a} > e \)

(b) \( a > 0, ab > e \)

(c) \( a > 0, \frac{b}{a} < e \)

(d) \( a < 0, \frac{b}{a} < e \)

(e) \( a < 0, ab < e \)
15. \( \lim_{x \to \infty} \frac{\sqrt{2x^2 + 1}}{3x - 5} = \)

(a) \(-\frac{\sqrt{2}}{3}\)

(b) \(\frac{\sqrt{2}}{3}\)

(c) \(\frac{\sqrt{3}}{2}\)

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

(e) \(\infty\)

16. The function \( y = \ln(\tan^2 x) \) on the interval \( \left[ \frac{\pi}{10}, \frac{11\pi}{10} \right] \) is discontinuous if

(a) \( x = \frac{\pi}{2} \) and \( x = \pi \) only

(b) \( x = \frac{\pi}{2} \) only

(c) \( x = \frac{\pi}{3} \) and \( x = \frac{2\pi}{3} \) only

(d) \( x = \frac{2\pi}{3} \) only

(e) \( x = \pi \) only
17. The cost (in dollars) of producing \( x \) units of a certain commodity is

\[
C(x) = 4 + 13x + x^2.
\]

The average rate of change with respect to \( x \) when the production level is changed from \( x = 10 \) to \( x = 12 \) is

(a) 35  
(b) 34  
(c) 36  
(d) 33  
(e) 37

18. Let \( f(x) = x[x] \), where \([x]\) denotes the greatest integer that is less than or equal to \( x \), then \( f'(0) = \)

(a) -1  
(b) -2  
(c) 0  
(d) 1  
(e) 2
19. Suppose $f$ is a function that satisfies the equation

$$f(x + y) = f(x) + f(y) - f(x)f(y)$$

for all real numbers $x$ and $y$. If $f(0) = 1$, then $f'(0)$ equals to:

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

20. The function \( f(x) = x - \ln(3e^x + 1) \) has

(a) only one horizontal asymptote and no vertical asymptotes
(b) only one horizontal asymptote and one vertical asymptote
(c) only one vertical asymptote and no horizontal asymptotes
(d) neither horizontal nor vertical asymptotes
(e) two horizontal asymptotes and no vertical asymptotes