1. Determine whether the statement is true or false. If it is true, explain why. If it is false, give an explanation or a counterexample.

   a) \( \lim_{x \to 4} \frac{x^2 - 16}{x - 4} = \lim_{x \to 4} (x + 4); \)

   b) If \( \lim_{x \to 3} f(x)g(x) \) exists, then the limit must be \( f(3)g(3); \)

   c) If \( f \) is continuous at \( a \), then \( f \) is differentiable at \( a; \)

   d) If \( f \) is continuous on \([−1, 1], f(−1) = 4 \) and \( f(1) = 3, \) then there is \( c \) with \(|c| < 1 \) such that \( f(c) = \pi. \)

2. Sketch the graph of a function that satisfy all conditions:

   \( \lim_{x \to -\infty} f(x) = -2, \lim_{x \to \infty} f(x) = 0, \lim_{x \to -3} f(x) = \infty, \lim_{x \to 3^-} f(x) = -\infty, \)

   and \( f \) is continuous from the right at 3.

3. Find the limits if they exist.

   a) \( \lim_{x \to 1^+} \frac{x^2 - 9}{x^2 + 2x - 3}; \)

   b) \( \lim_{h \to 0} \frac{(h - 1)^3 + 1}{h}; \)

   c) \( \lim_{x \to 3} \frac{\sqrt{x + 6} - x}{x^3 - 3x^2}; \)

   d) \( \lim_{x \to \infty} \frac{\sqrt{x^2 - 9}}{2x - 6}; \)

   e) \( \lim_{x \to \pi^-} \ln(\sin x); \)

   f) \( \lim_{x \to 0^+} \arctan(1/x); \)

   g) \( \lim_{x \to -\infty} (\sqrt{x^2 + 4x + 1} + x). \)

4. Use the Intermediate Value Theorem to show that the equation \( \cos \sqrt{x} = e^x - 2 \) has a root in \((0, 1). \)

5. If a ball is thrown into the air with a velocity of 44 ft/s, its height in feet \( t \) seconds later is given by \( y = 44t - 16t^2. \)

   a) Find the average velocity for the time period beginning when \( t = 2 \) and lasting for 0.5 seconds and 0.1 seconds.

   b) Find the instantaneous velocity when \( t = 2. \)
6. Graph the function \( f(x) = \begin{cases} 3 + x & \text{if } x < -2 \\ x^2 & \text{if } -2 \leq x < 2 \\ 6 - x & \text{if } x \geq 2 \end{cases} \) and check if it is continuous at \( a = -2 \) and differentiable at \( a = 2 \).

7. Find all the asymptotes for \( f(x) = \frac{x^2 - 5x}{x^2 - 4x - 5} \).

8. Find an equation of the tangent line to the graph of \( g(x) = \frac{x + 1}{|x - 1|} \) through the point \((2, g(2))\).

9. Use the graph of \( f(x) = \sqrt{x} \) to find a number \( \delta \) such that if \(|x - 4| < \delta\) then \(|\sqrt{x} - 2| < 0.1\).

10. Find the values of \( a \) and \( b \) that will make the function

\[
f(x) = \begin{cases} \frac{x^2 - 4}{x - 2} & \text{if } x < 2 \\ ax^2 - bx + 1 & \text{if } 2 \leq x < 3 \\ 4x - a + b & \text{if } x \geq 3 \end{cases}
\]

continuous everywhere.

11. Let \( f(x) = \sqrt{x + 1} \). Use the definition of the derivative to compute \( f'(x) \) and \( f''(0) \).

12. The following limits represent the derivative of some function \( f \) at some number \( a \). Determine \( f \) and \( a \):

\[
a) \lim_{h \to 0} \frac{\sqrt{9 + h} - 3}{h}, \quad b) \lim_{h \to 0} \frac{e^{-2 + h} - e^{-2}}{h}, \quad c) \lim_{\theta \to \pi/6} \frac{\sin \theta - 1/2}{\theta - \pi/6}.
\]

13. Show that \( g(x) = x|x| \) is differentiable everywhere and compute \( g'(-1) \). Graph the functions \( g \) and \( g' \).

14. Let \( f(x) = \begin{cases} x \cos \frac{1}{x} & x \neq 0 \\ 0 & x = 0 \end{cases} \). Is \( f \) continuous at \( a = 0 \)? Is \( f \) differentiable at \( a = 0 \)?

15. If \( 2x - 1 \leq f(x) \leq x^2 \) for \( 0 < x < 2 \), compute \( \lim_{x \to 1} f(x) \).

16. Since \( \lim_{x \to 1} \frac{1}{(x - 1)^2} = \infty \), given \( M = 10000 \) find \( \delta > 0 \) such that \( 0 < |x - 1| < \delta \) implies \( \frac{1}{(x - 1)^2} > M \).