1. If $f(x) = \sin x$ and $g(x) = x^2$, compute $(f \circ g)(x)$, and $(g \circ f)(x)$. Are they equal?

2. Find the domain of $f(x) = \frac{\sqrt{x - 5}}{x^4 - 16}$.

3. Compute each of the following limits.
   
   (a) $\lim_{x \to 2} \frac{3x^2 - 4}{x + 2}$
   
   (b) $\lim_{x \to -2} \frac{x^2 - 4}{x^3 + 4x^2 + 4x}$
   
   (c) $\lim_{x \to \infty} \sin(2x)$
   
   (d) $\lim_{x \to \infty} \frac{7 - 3x^2}{2x^2 + 1}$
   
   (e) If $e^{-2x} < f(x) < \frac{2}{x^3}$ for $x > 0$, what is $\lim_{x \to \infty} f(x)$?

4. Suppose that an object is dropped a 1000 foot cliff, and has position given by $s(t) = 1000 - 10t^2$ at any time $t$ in seconds.

   (a) What is the object’s average velocity during the first 5 seconds?
   
   (b) Use the definition of the derivative to compute the velocity of the falling object.
   
   (c) How fast is the object travelling at $t = 5$ seconds?

5. Differentiate the following functions.

   (a) $y = 45x^{10} + 7x^8 - 5x^3 + 2x - \pi$
   
   (b) $y = \frac{7x + 8}{\sqrt{x}}$
   
   (c) $y = xe^x$ (Use the fact that $\frac{d}{dx}e^x = e^x$.)
   
   (d) $y = \frac{2x + 1}{x^3 - 9}$

6. Find the equation of the tangent line to $y = \frac{2x + 1}{x^3 - 9}$ at $x = 2$.

7. Using the Intermediate Value Theorem, explain why $f(x) = x^7 - 3x + 1$ has at least one real root.

8. (a) Carefully define what it means for $y = f(x)$ to be continuous at $x = a$.
   
   (b) How can a function fail to be continuous at a point?
(c) Suppose that \( f(x) = \frac{x^3 - 49x}{x - 7} \) for all \( x \neq 7 \).

How should we define \( f(7) \) so that \( f \) is continuous at \( x = 7 \)?

9. Give an example of a continuous function that fails to be differentiable at a point.

10. Be able to read limits from the graph of a function.
Answers:

1. \((f \circ g)(x) = \sin(x^2)\) and \((g \circ f)(x) = \sin^2 x\); these are not equal.

2. The domain is \([5, \infty)\).

3. (a) 2, (b) DNE, (c) DNE, (d) \(-\frac{3}{2}\), (e) 0, (f) 0

4. (a) \(-50\) ft/sec, (b) \(-20t\), (c) \(-100\) ft/sec.

5. (a) \(450x^9 + 56x^7 - 15x^2 + 2\), (b) \(\frac{14}{7}x^{-1/3} - \frac{8}{3}x^{-4/3}\), (c) \((x^7 + 7x^6)e^x\), (d) \(\frac{-(4x^3 + 3x^2 + 18)}{(x^3 - 9)^2}\).

6. \(y + 5 = -62(x - 2)\)

7. Note that \(f\) is a continuous function on \(\mathbb{R}\), and \(f(0) > 0\), while \(f(1) < 0\).

8. (a) \(f(a) = \lim_{x \to a} f(x)\), assuming that both quantities exist.
   (b) Removable, jump, or infinite discontinuities are examples.
   (c) For \(f\) to be continuous at \(x = 7\), we need \(f(7) = \lim_{x \to 7} f(x) = 98\).

9. Corner points (such as \(f(x) = |x|\) at \(x = 0\)) or vertical tangents (such as \(y = x^{1/3}\) at \(x = 0\)).