1. Give a value for each of the following limits. (4 points each)

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

(b) \( \lim_{x \to 2^+} \frac{|1 - x^2|}{x - 2} \)

(c) \( \lim_{t \to 0} \left( \frac{1}{t} - \frac{1}{t^2 - t} \right) \)

2. Determine the derivatives of the following functions. (4 points each)

(a) \( f(x) = \sqrt[3]{x} + (1 + x)^{99} \)

(b) \( f(x) = (x^3 + 1)^6 \sin(x) \)
(c) \[ f(x) = \frac{x^3 + x}{3x^2 - 1} \]

(d) \[ f(x) = \tan(\cos(x^2)) \]

(e) \[ f(x) = \frac{1}{x + \sin^2(x + x^2)} \]

3. Suppose that \( \lim_{x \to 1} \frac{f(x) - 4}{x - 1} = 9 \). Find \( \lim_{x \to 1} f(x) \). Justify your answer. (8 points)
4. Determine the equation of the tangent line to the curve
\[ x \sin(y) - x^2 \cos(y) = 1 \]
at the point \((1, \pi/2)\). (10 points)

5. A diamond shaped car jack is tightened, pulling the left and right corners together at a rate of 1mm/s.

Suppose that all sides of the jack are 300mm long. Find the rate at which the car is raised when \(\theta = 2\pi/3\). Feel free to leave square roots in your answer. (10 points)
6. Determine where the function \( f(x) = \frac{x^2 - x}{x^2 - 1} \) has a horizontal tangent line. (8 points)

7. Suppose that \( f(x) \) is a differentiable function with \( f(1) = 8 \) and \( f'(1) = -3 \). Let \( h(x) = \sqrt{1 + f(x^2)} \). Find \( h'(1) \). (10 points)

8. Let \( f(x) = \sqrt[3]{x} \).

   (a) Find a linear approximation to \( f(x) \) near \( x = a \). (5 points)

   (b) Approximate \( \sqrt[3]{8.012} \). (5 points)
9. Match each graph with its derivative. (3 points per correct match)