1. Give a value for each of the following limits (including $\infty$ or $-\infty$ if applicable). (4 points each)

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

(b) $\lim_{\theta \to \pi^-} \cot(\theta)$

(c) $\lim_{t \to 0} \left( \frac{1}{t^2 - t} + \frac{1}{t^2 + t} \right)$
2. Consider the functions $f(x)$ and $g(x)$ shown below:

$$f(x) \quad g(x)$$

(a) Find $\lim_{x \to 2} g(f(x))$. (4 points)

(b) Where is $f(x)$ continuous? (1 point)

(c) Where is $g(x)$ continuous? (1 point)

(d) Where is $g(f(x))$ continuous? Justify your answer. (6 points)
3. Determine the derivatives of the following functions. (4 points each)

(a) \( f(x) = (\sin((1 + x)^7))^3 \)

(b) \( f(x) = x \sin(x) \sqrt[3]{1 + x} \)

(c) \( f(x) = \frac{x + \tan(x)}{1 - \cos^2(x)} \)

(d) \( f(x) = x^2 \sin \left( \frac{1}{x} \right) \)

(e) \( f(x) = (x^3 + 2)^5(x^2 - 2)^{-7/2} \)
4. Find an equation for the tangent line to the curve

\[ y \cos(x) = 2 + \sin(xy) \]

at the point \((0, 2)\). (10 points)

5. A balloon is being filled with air at a rate of \(100 \text{ cm}^3/\text{s}\). Assuming that the balloon is spherical, how fast is its surface area increasing when its radius is 5 cm? (10 points)
6. Determine the tangent lines to the function \( f(x) = \frac{x^2+3x+1}{x-1} \) with slope \(-1\). (10 points)

7. Suppose that \( f(x) \) is a differentiable function, and \( h(x) = \sqrt{1-f(x)} \). If \( h(1) = 2 \) and \( h'(1) = -4 \), find \( f'(1) \). (10 points)
8. Let \( f(x) = x^9 \).

(a) Find a linear approximation to \( f(x) \) near \( x = a \). (4 points)

(b) Approximate \( (1.01)^9 \). (4 points)
9. Match each graph with its derivative. (2 points per correct match)

(a) \( f(x) \)  
(b) \( f(x) \)  
(c) \( f(x) \)  
(d) \( f(x) \)  

(a)  
(b)  
(c)  
(d)