

Answer the problems on separate paper. You do not need to rewrite the problem statements on your answer sheets. Do your own work. Show all relevant steps which lead to your solutions. Retain this question sheet for your records.

1. Find each of the following limits, if they exist:

a. (7) $\lim_{x \rightarrow 1} \frac{x^2 + x - 3}{x + 1}$ b. (7) $\lim_{x \rightarrow 2} \frac{x^2 + 2x - 8}{x^2 - x - 2}$ c. (7) $\lim_{x \rightarrow 1} \frac{1 - \sqrt{x}}{x - 1}$

2. Identify all points of discontinuity for each of the following functions. For each such point, explain why the function is discontinuous at that point:

a. (7) $f(x) = \frac{x - 1}{e^{x-1}}$ b. (7) $g(x) = \begin{cases} -x - 2 & x < 0 \\ 2x - 3 & 0 \leq x \leq 1 \\ x^2 - 2 & x > 1 \end{cases}$

3. (7) Using the definition, find $f'(x)$ for $f(x) = x - 2x^2$.

4. Find the first derivative of each of the following functions. Algebraically simplify any sums or quotients which may arise.

a. (7) $y = \sqrt{3x} + \frac{3}{x^2}$ b. (7) $y = \frac{\sin x}{1 + \cos x}$ c. (7) $y = e^x(\cos x + \sin x)$

5. Find the second derivative of each of the following functions. Algebraically simplify any sums or quotients which may arise.

a. (10) $y = \frac{x + 1}{x - 1}$ b. (10) $y = x(x^2 + 3)^{\frac{7}{2}}$

6. Consider $y = f(x) = x^3 - 5x^2 - 12x + 36$. It can be easily verified (by factoring) that f has three roots: -3, 2 and 6.

- a. (7) Find the equation of the tangent to the graph of f at $x = 4$. (As an aside, note that 4 is the midpoint of the roots 2 and 6.)

- b. (3) Find the x-intercept of the above found tangent line.

7. (7) A Lady Raider is standing on the observation deck at the top of a tall building in Dallas. She throws a basketball "straight up" into the air with an initial velocity of 80 ft/sec. While the basketball is in the air, she *quickly* makes her way to the ground-level floor, goes out the front door and catches the basketball just as it comes down. If the flight distance the basketball fell was three times the flight distance it traveled up, how tall was the building?