Below you will find 10 problems, each worth 10 points. Solve the problems in the space provided. When writing a solution to a problem, show all work. No books or notes are allowed.

Problem 1. Find the derivative of $f(x) = x\sqrt{x^2 + 1}$. (DO NOT SIMPLIFY.)

Problem 2. A rectangular page is to contain 54 square inches of print with 2 inches margin on top, and 1 inch margins on left, right, and bottom. Find the dimensions of the page that uses the least amount of paper.
Problem 3. The function $f(x) = x + 1 + \frac{1}{x - 1}$ has its first and second derivatives already computed: $f'(x) = \frac{x^2 - 2x}{(x - 1)^2}$ and $f''(x) = \frac{2}{(x - 1)^3}$.

(a) Indicate the intervals where $f(x)$ is increasing/decreasing, and concave upward/downward.

(b) Find all the asymptotes (horizontal/slant/vertical, if any).

(c) Sketch (use the white space on the right) the graph of $f(x)$. Below list intercepts, critical points, and inflection points (if any).

Problem 4. Find the critical numbers of $f(x) = \sqrt[3]{x^2 - 2x}$. 
Problem 5. Given the equation \( x^3 + y^2 = 5 \), use implicit differentiation to find the derivative \( dy/dx \) at the point \((1, -2)\).

Problem 6. The side of a square region decreases at a rate of 1 inch per second. What is the rate of change of the area, when the side is 20 inches?

Problem 7. Find the absolute extrema of the function \( f(x) = x^3 - 12x \), in the interval \([-3, 1]\).
Problem 8. How many zeros does the function \( f(x) = x^3 - 1200x + 1 \) have?

Problem 9. Find the intervals where the function \( f(x) = \frac{x^2 + x + 4}{x + 1} \) is increasing/decreasing. Find relative maximum/minimum points.

Problem 10. Consider the function \( f(x) = x^2 + 4 \sin x \), defined on \([0, 2\pi]\). Find the inflection points, and the intervals where \( f(x) \) is concave upward/downward.