



1. (1 point) True or false: I hate limits which contain square roots.
2. (a) (7 points) State carefully the definition of the derivative of a function.

(b) (16 points) If  $f(x) = \frac{1}{8-x}$ , compute the derivative  $f'(2)$  *directly from the definition*. (You should check your answer using the differentiation formula, but no credit will be given for just using the formula.)

3. (6 points) Express the following statement in terms of calculus. Be sure to define everything that appears in your formulas.

“The population of New York City was decreasing throughout the period 1980–1990.”

4. (12 points/part) Find the exact values of the following limits, or explain why they do not exist:

(a)  $\lim_{x \rightarrow 0} \frac{3x}{\sin(cx)}$ , where  $c$  is a nonzero constant.

(b)  $\lim_{x \rightarrow \infty} \frac{\sqrt{3x^2 + 2}}{9x + 7109}$ .

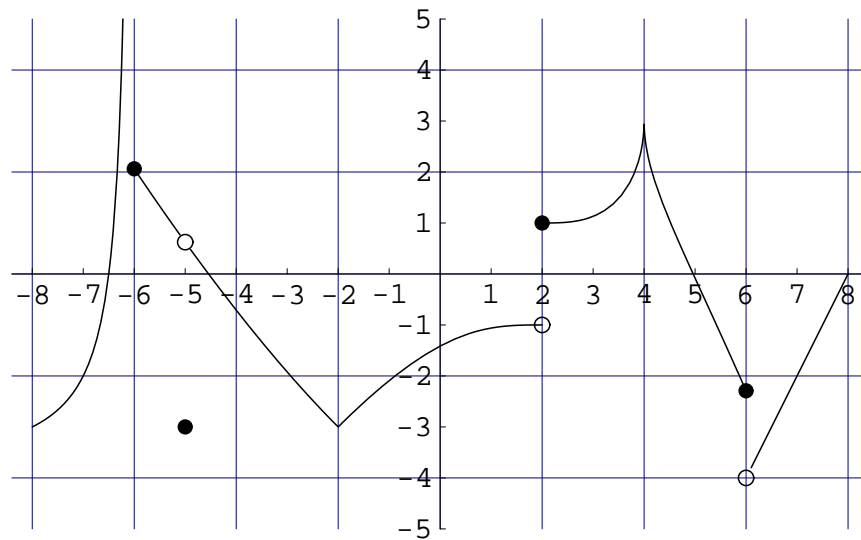
5. (12 points/part)

(a) Differentiate the function  $q(t) = \frac{1 - ke^t}{1 + ke^t} + \sqrt[3]{\pi}$ , where  $k$  is a constant.

(b) Let  $g$  be a function such that  $g'(x) = \sin(x) - e^{x^2}$ . Find the derivative of the function  $h(t) = \frac{1}{\sqrt{t}} + e^3 - tg(t)$ . (Your answer might involve the function  $g$ .)

6. (14 points) Let  $c$  be a constant. Find the equation of the tangent line to the graph of  $q(x) = 1/x^2 + c$  at  $x = 2$ . You need not calculate the derivative directly from the definition.

7. (4 points/part) For the function  $y = h(x)$  graphed below, answer the following questions:



(a) List all numbers  $a$  in  $(-8, 8)$  such that  $h$  is continuous at  $a$  but not differentiable at  $a$ . Give reasons.

(b) List all numbers  $a$  in  $(-8, 8)$  such that  $h$  is differentiable at  $a$  but not continuous at  $a$ . Give reasons.

Extra credit. (Do not attempt these problems until you have done and checked your answer to all the ordinary problems on this exam. They will only be counted if you get a grade of B or better on the main part of this exam.)

Write answers after all the extra credit problems.

EC. (5 extra credit points/part)

(a) Let  $f(x) = \sin(x)$ . Find the 1167th derivative  $f^{(1167)}(x)$ .

(b) Let  $g(x) = x^{1167}$ . Find the 1167th derivative  $g^{(1167)}(x)$ .

(c) Let  $h(x) = \frac{1}{x^2}$ . Find the 1167th derivative  $h^{(1167)}(x)$ .