

Full Name: \_\_\_\_\_ Instructor &amp; Section: \_\_\_\_\_

<b>Instructions:</b> Complete this section and hand it in after 40 minutes. Use no calculators. Show all work.
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1. For each of the following, evaluate the limit or give reasons why it does not exist. Each problem is worth 5 points.

a.  $\lim_{x \rightarrow 3} \left| \frac{x^2 + x - 12}{x^2 - 6x + 9} \right|$ .

b.  $\lim_{r \rightarrow \infty} \frac{2r^2 - 4r + 2}{7r^2 + 3r - 12 \sin r}$ .

c.  $\lim_{h \rightarrow 2} \frac{(h^2 - 4) \sin(h - 2)}{h^2 - 4h + 4}$ .

- d.  $\lim_{\theta \rightarrow \pi} H(\theta)$  where  $H(\theta)$  is defined by

$$H(\theta) = \begin{cases} 2 + \cos \theta & \theta < \pi \\ 1 & \theta = \pi \\ 2 + \sin \theta & \theta > \pi. \end{cases}$$

2. (5 points) Find  $\frac{dr}{dt}$  if  $r = 6t^7 - \sqrt{5} - \sqrt[3]{t} + \frac{3}{t^4}$
3. (5 points) Find  $g'(z)$  if  $g(z) = (2z^4 - 4 \sin z)(2z - 3 \cos z)$ . (You do not have to simplify your answer.)
4. (5 points) Find  $D_x F$  if  $F(x) = \frac{x^2 + 1}{1 - 2 \cos x}$ . (You do not have to simplify your answer.)
5. (5 points) The equation  $xy^2 = (x + 4y)^4 - 14$  defines  $y$  as a function of  $x$ . Find the value of  $\frac{dy}{dx}$  at the point with  $x = 2$  and  $y = -1$ .
6. (5 points) Find  $\frac{d^3 h}{ds^3}$  if  $h(s) = -4 \sin(3s)$ .

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**Instructions:** Answer each question completely. Show all work. **No credit** will be awarded for mere answers with no work shown. Show the steps of calculations. Clearly state the reasons that justify conclusions.

1. Let  $f(x) = 6x^2 - \frac{3}{x}$ .

(a) (6 points) Use the **limit definition of the derivative** to find  $f'(x)$ . (No credit for using the quick derivative rules.)

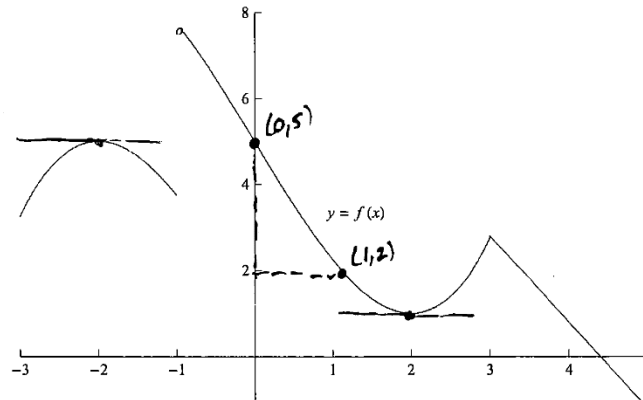
(b) (6 points) Find an equation for the line tangent to the graph of  $y = f(x)$  at the point with  $x = -3$ .

2. Trevor's calculator died in the middle of the Math 165 midterm, so after the exam he went to the roof garden of his Ames apartment and hurled his calculator upward from the roof. The calculator left his hand with an upward velocity of 48 feet per second from a height of 120 feet above the ground, so its height above ground  $t$  seconds after leaving his hand was

$$h(t) = 120 + 48t - 16t^2 \text{ feet.}$$

- a) (3 points) How many seconds after leaving Trevor's hand did the calculator reach its maximum height above ground?
- b) (3 points) What was the maximum height reached by the calculator?
- c) (3 points) At what time did the calculator hit the ground? (Your answer should be exact, that is, not a decimal approximation.)
- d) (3 points) What was the calculator's velocity on impacting the ground? (Your answer should be exact, that is, not a decimal approximation.)

5. (10 points) The graph of a function  $f$  is shown below.



- Using the graph estimate the value of  $f'(0)$
- Find all solutions to the equation  $f'(x) = 0$ .
- On what interval(s), if any, is  $f'(x) > 0$ ?
- At what points, if any, is  $f$  not continuous?
- At what points, if any, does  $f$  fail to be differentiable?