

*I pledge that I have neither given nor received
unauthorized assistance during this examination.*

Signature:

- **DON'T PANIC!** If you get stuck, take a deep breath and go on to the next question.
- Unless the problem says otherwise **you must show your work** sufficiently much that it's clear to me how you arrived at your answer.
- You may use any sort of calculator, but not a phone or a computer.
- It is okay to leave a numerical answer like $\frac{39}{2} - (18 - e^2)$ unsimplified.
- You may bring a two-sided sheet of notes on letter-sized paper in your own handwriting.
- There are 6 problems on 9 pages.

Question	Points	Score
1	16	
2	13	
3	10	
4	16	
5	9	
6	10	
Total:	74	

Good luck!

[16 points] 1. (a)

$$\lim_{x \rightarrow \infty} \frac{3x^2 + x - 1}{2x^2 + 4} =$$

(b)

$$\lim_{x \rightarrow 1} \frac{x^2 + 3x - 4}{x - 1} =$$

(c)

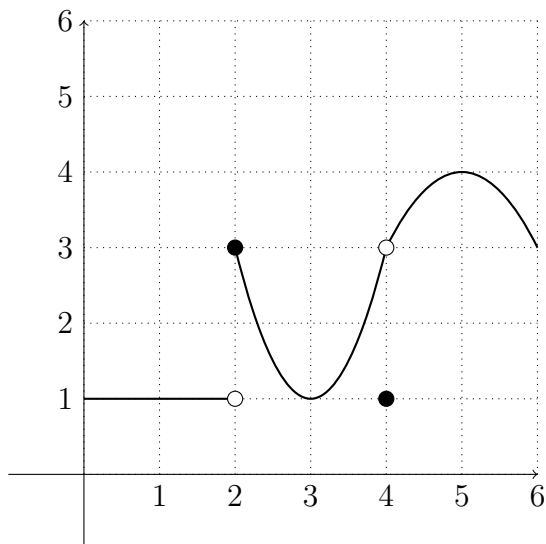
$$\lim_{x \rightarrow 3} \frac{x^2 + 4}{x^2 - 9} =$$

(d)

$$\lim_{x \rightarrow \infty} \sin\left(\frac{\pi(x^2 + 1)}{4x^2 + 1}\right) =$$

Note: you will get a bonus point on this problem if you give the exact answer rather than a numerical approximation.

- [13 points] 2. Here is a graph of a function $f(x)$. Find the following quantities. If a limit does not exist, say so. (If a limit diverges to infinity, it is acceptable either to say that it doesn't exist, or to say that it diverges to infinity, or to write down that its limit is ∞ or $-\infty$.) You do not need to show any work on this problem.



(a) $\lim_{x \rightarrow 2^-} f(x) =$

(g) $\lim_{x \rightarrow 3} f(x) =$

(b) $\lim_{x \rightarrow 2^+} f(x) =$

(h) $f(3) =$

(c) $\lim_{x \rightarrow 2} f(x) =$

(i) $\lim_{x \rightarrow 4^-} f(x) =$

(d) $f(2) =$

(j) $\lim_{x \rightarrow 4^+} f(x) =$

(e) $\lim_{x \rightarrow 3^-} f(x) =$

(k) $\lim_{x \rightarrow 4} f(x) =$

(f) $\lim_{x \rightarrow 3^+} f(x) =$

(l) $f(4) =$

(m) $f'(3) =$

- [10 points] 3. Compute the derivative $g'(3)$, where $g(x) = \sqrt{x+1}$, **using the definition of the derivative**. You will not receive credit for computing the derivative using differentiation rules. You must compute it directly using the limit definition of the derivative.

[16 points] 4. Find the following derivatives.

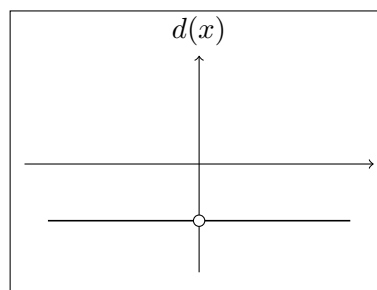
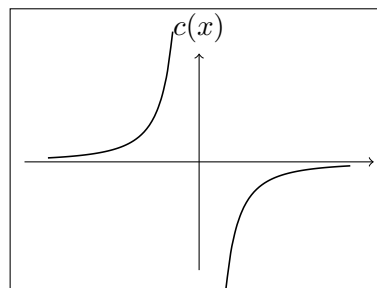
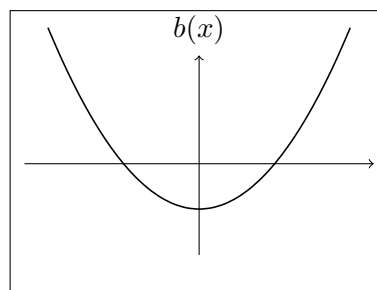
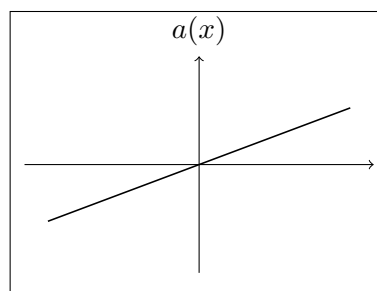
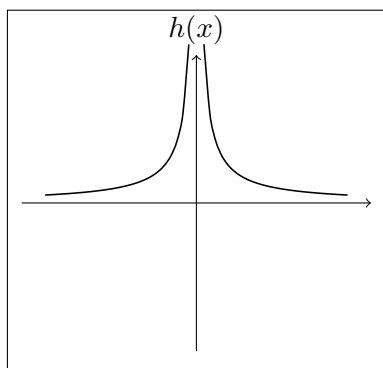
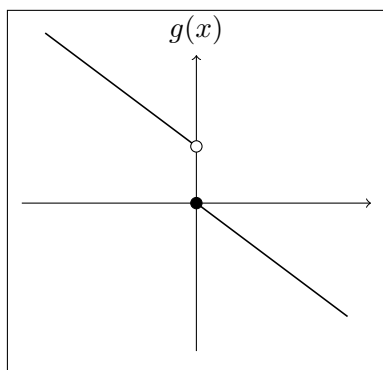
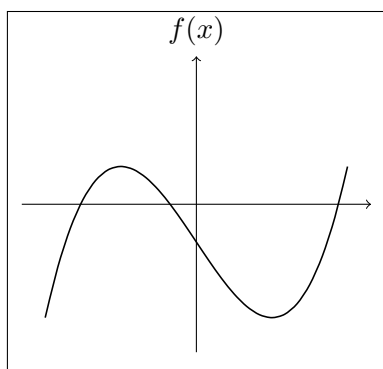
(a) Let $f(x) = 3x^2 + 4x + 5$. Find $f'(x)$.

(b) Compute $\frac{d}{dt} \left(te^t + \frac{1}{\sqrt{t}} \right)$.

(c) Compute $\frac{d}{dx} \left(\frac{x+1}{x^2+1} \right)$.

(d) Let $f(x) = \frac{5x^4 + x}{x}$. Find $f'(x)$.

- [9 points] 5. On the left are three functions $f(x)$, $g(x)$, and $h(x)$. On the right are four functions, $a(x)$, $b(x)$, $c(x)$, and $d(x)$.



Circle one answer for each question. You do not need to explain yourself or show work.

(a) The derivative of $f(x)$ is... $a(x)$ $b(x)$ $c(x)$ $d(x)$ none of the above

(b) The derivative of $g(x)$ is... $a(x)$ $b(x)$ $c(x)$ $d(x)$ none of the above

(c) The derivative of $h(x)$ is... $a(x)$ $b(x)$ $c(x)$ $d(x)$ none of the above

- [10 points] 6. Let $g(x) = \frac{e^x}{x^2 + 1}$. Find all x -coordinates where the graph of this function has a horizontal tangent line.

This page can be used as scratch paper.