The following exercises represent some of the most important concepts from Math 105L. As we begin Math 106L together, it is important to refresh these concepts, and the problems below will help you to review. Work in class to complete the statements or answer the questions, using a separate piece of paper if you need more room. Feel free to work with others in the class, but you must submit your own worksheet by midnight on Sunday.

Each exercise on this worksheet includes a reference to the relevant 105L worksheet. You may find your 105L worksheets on Gradescope.

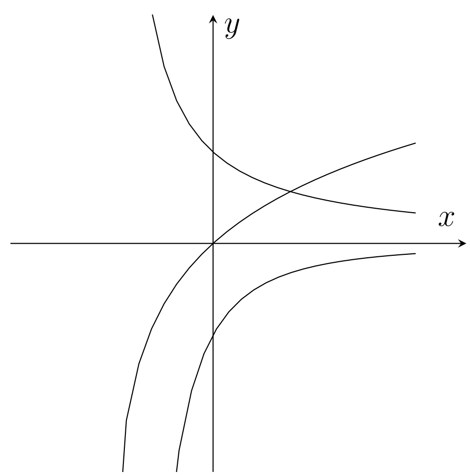
1. (105L worksheet: The Derivative Function) The derivative of a function $f(x)$ is defined to be:

$$f'(x) = \lim_{h \to 0}$$

2. (105L worksheet: Linear Approximations) Find the linear approximation to the function $f(x) = xe^{kx}$ at $x = 0$. Assuming that $k > 0$, does the linear approximation overestimate or underestimate xe^{kx} near 0? Explain your answer carefully.

3. (105L worksheets: The Derivative Function, The Second Derivative, and Using First and Second Derivatives)

   On the axes to the right, identify which graph represents $f(x)$, which represents $f'(x)$ and which represents $f''(x)$. Briefly explain your reasoning.



4. (105L Linear modeling lab, Chain Rule Worksheet) Using the table below, estimate $\frac{d}{dx}f(g(x))$ at $x = 1.3$ as closely as possible. Explain your reasoning. (Hint: You will need the chain rule, but you will also need to estimate derivatives. What is the ideal way to estimate them from data?)

x	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
$f(x)$	1.4	1.2	1.1	1.0	1.3	1.4	1.7	1.5	1.6	2.1	2.2
$g(x)$	0.9	1.4	2.2	2.0	1.9	1.5	2.2	3.1	2.5	2.2	2.3

5. (105L worksheet: Related Rates) Suppose that you are watching a rocket take off. You are $1,500$ meters from the launch site. At time t seconds after launch, the height of the rocket in meters is given by $h(t) = 1.39t^2 - 1.65t$. Find the rate at which the distance between you and the rocket is changing at time 10 seconds after launch. You may assume that the rocket rises vertically, and that the ground is flat.

6. (105L worksheets: Power Functions and Polynomials, Rational Functions) A general rational function can be written as

$$f(x) = \frac{a_n x^n + a_{n-1}x^{n-1} + \ldots + a_2x^2 + a_1x + a_0}{b_m x^m + b_{m-1}x^{m-1} + \ldots + b_2x^2 + b_1x + b_0}.$$

Fill in the following blanks:

- If $m > n$, then $f(x)$ has a horizontal asymptote at ____.
- If m___n, then $f(x)$ has a horizontal asymptote at ____.
  (The blanks here should have different answers than in the first bullet point).

7. (105L worksheet: Differentiability) Fill in the blanks with the words *continuous* and *differentiable*:

- If $f(x)$ is not ____________ at $x = a$, then it is not ____________at $x = a$;
- If $f(x)$ is ____________at $x = a$, then it is ____________at $x = a$;
- It is possible for $f(x)$ to be ____________at $x = a$, but not ____________there.

8. (105L worksheets: Exponential Functions, Logarithms) Fill in the blanks:

	$f(x) = 10^x$	$f(x) = \log x$
Domain	____________	____________
Range	____________	____________
x intercept	____________	____________
y intercept	____________	____________
Horiz. asymptote	____________	____________
Vert. asymptote	____________	____________

9. (105L worksheets Logarithms, Differentiating Logarithmic Functions)

   (a) $\ln x$ is the inverse of what function?

   (b) Using the derivative of its inverse, show why $\frac{d}{dx}\ln x = \frac{1}{x}$

10. (105L Derivatives and Roots lab) In each of the following, draw a graph of a *differentiable* function $f(x)$ with domain $(-\infty, \infty)$ that satisfies the given conditions. If it is not possible, explain why. Your graph should make it clear what the behavior of $f(x)$ is as x approaches $-\infty$ and ∞.

    (a) $f'(x)$ has three distinct zeroes and $f(x)$ has one zero.

    (b) $f(x)$ has three distinct zeroes and $f'(x)$ has one zero.

11. (105L worksheets Using First and Second Derivatives, Optimization - Global Extrema) Without using a calculator, find the the global max and min of $f(x) = x^2e^{2x}$ on $[0, \infty)$.