1. Recall the formal definition of the limit that we worked out last time, and write it down carefully. Then, using that definition, formally prove the following limits.
   (a) $\lim_{x \to 2} 3x - 1 = 5$
   (b) $\lim_{x\to 2} x^2 = 4$
   (c) $\lim_{x\to 3} x - 9 = -6$
   (d) $\lim_{x\to 5} \frac{1}{x} = \frac{1}{5}$
2. (a) Given a function $f(x)$, write down a formula for the secant line between the points $(a, f(a))$ and $(x, f(x))$. Sketch a picture showing the secant line.
   (b) Using a limit, write a formula for the slope of the tangent line at the point $(a, f(a))$. This is called the derivative of f at a, and is written $f'(a)$.
   (c) We can express the same derivative in a different way. Sketch the same picture as above, but now label the distance between x and a by h. Write an expression for $f'(a)$ in terms of a and h. (Note that you can also let x play the role of a above and get an expression for $f'(x)$ for any x.)
3. Let $f(x) = x^2$.
   (a) Using each of the above definitions, evaluate $f'(0)$ and $f'(1)$. Verify on a sketch that these slopes make sense.
   (b) Find an expression for $f'(x)$ that is valid for all values of x.
4. Let

$$f(x) = \begin{cases} -x & : x \leq 0 \\ x^2 & : x > 0 \end{cases}$$

   (a) Is $f(x)$ continuous at $x = 0$?
   (b) Is $f'(0)$ defined? If so, what is it?
5. Let $f(x) = \sqrt{x+1}$.
   (a) Evaluate $f'(3)$
   (b) Find an expression for $f'(x)$ that is valid for all values of x.