From the 2.1 Activity, for the function $f(x) = x^2$: it looks like $m_{tan}(a)$ should be $2a$, regardless of which number a we are looking at.

Definition. The derivative of $f(x)$, denoted by $f'(x)$, is the function defined by

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h},$$

wherever that limit exists.

Note. To determine something like $f'(3)$, we could use 3.1 methods *or* we could determine $f'(x)$ using our new formula, and then plug in 3 for x at the end.

Terminology. Determining the derivative is called differentiating or differentiation.

Alphabet soup. These mean the same thing: $f'(x), \quad f', \quad \frac{d}{dx}(f), \quad \frac{dy}{dx}, \quad y', \quad \frac{df}{dx}$

1. Use the *definition of the derivative* to determine the derivative of $f(x) = x^2$.

2. Use the definition of the derivative to determine the derivative of $g(x) = \sqrt{2+x}$.

3. Use the definition of the derivative to determine the derivative of $y = \frac{x}{3-x}$. Then determine an equation of the tangent line to the graph of f at $(2, 1)$.

Definition. If $f'(a)$ exists, we say that f is differentiable at a.

4. Determine where $f(x) = x^2$ is differentiable.

5. Determine where $g(x) = \sqrt{2+x}$ is differentiable.

Theorem. If f is differentiable at a, then f is continuous at a.

6. Determine intervals where $g(x) = \sqrt{2+x}$ is *continuous*.

Caution. A function might be continuous at a number but not differentiable at that same number!!

7. Determine intervals where $f(x) = |x|$ is continuous. Determine the derivative of $f(x) = |x|$, and determine intervals where $f(x)$ is differentiable.

8. Use the definition of the derivative to differentiate $y = \dfrac{2}{\sqrt{1-7x}}$.