

Formal Limit Definition of Derivative

The derivative of f at x is given by

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

provided this limit exists. If $f'(x)$ exists, we say f is differentiable at x . The process of finding the derivative of a function is called differentiation.

Direct substitution of $h = 0$ into the definition will **always** yield the indeterminate form $0/0$. There will always be more work to do.

Common Ways Derivatives Fail to Exist

f is not differentiable at $x = c$ if

- f is discontinuous at $x = c$,
- the slope of the graph's tangent line from the left at $x = c$ is not equal to the slope of the tangent line from the right (i.e. the graph has a sharp point at $x = c$), or
- the tangent line at $x = c$ is vertical.