

1 | Definition

2 | A Problem

Normal or "easy" limits are rather simple, as examples like $\lim_{x \rightarrow 4} \frac{x+3}{x^2+1}$ just need some plugging in. Derivatives are usually harder as $\lim_{x \rightarrow 0} \frac{f(x_0+\Delta x) - f(x_0)}{x - x_0}$ always evaluates to $\frac{0}{0}$, and needs some cancellation.

3 | Some Notation

DEFINITION Right hand limit or $\lim_{x \rightarrow x_0^+} f(x)$ indicates that x is greater than x_0 (or that x begins on the right side of the number line).

DEFINITION Left hand limit or $\lim_{x \rightarrow x_0^-} f(x)$ indicates that x is less than x_0 (or that x begins on the left side of the number line). These notations will make dealing with limits of these functions more convenient.

EXAMPLE Take the following example of a conditional function:

$$\text{if } x > 0, f(x) = x + 1$$

$$\text{if } x < 0, f(x) = -x + 2$$

$$\lim_{x \rightarrow x_0^+} f(x) = \lim_{x \rightarrow x_0} x + 1 = 1$$

$$\lim_{x \rightarrow x_0^-} f(x) = \lim_{x \rightarrow x_0} -x + 2 = 2$$

We did not need a $x = 0$ value to compute these limits!

4 | Nested Limits

A checklist for what to do before dealing with nested limits.

EXAMPLE: $\sin \sqrt{x}$

- ☐ Check domain + range of inner function (in this case $[0, \infty)$, $[0, \infty)$).
- ☐ Check domain + range of outer function as well as what it takes in. (takes in $[0, \infty)$, range is $[-1, 1]$)
- ☐ Restrict domain based on requirements of inner + outer functions

EXAMPLE: $\ln \sin x$

- ☒ Domain of $\sin x$ is $(-\infty, \infty)$, range is $[-1, 1]$.
- ☒ Domain of $\ln x$ is $(0, \infty)$, range is $(-\infty, \infty)$.
- ☒ As $\ln x$ takes only positive values, the restricted domain for the composite function is $[0, \pi]$, $[2\pi, 3\pi]$, etc. The range of the composite function would be $(-\infty, 0]$.

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5 | **Links**

Adjacent to this: Continuity

Building upon this: Calculating Derivatives

Further reference can be found at Limits and Continuity Practice.