

## Comparing Growth of $\ln(x)$ and $x^{\frac{1}{3}}$

We have one more item on our original list of limits to cover; again we'll look at a slight variation on the original problem. We're going to find:

$$\lim_{x \rightarrow \infty} \frac{\ln x}{x^{1/3}}.$$

This limit is of the form  $\frac{\infty}{\infty}$ , so we apply l'Hôpital's rule to find:

$$\begin{aligned} \lim_{x \rightarrow \infty} \frac{\ln x}{x^{1/3}} &= \lim_{x \rightarrow \infty} \frac{1/x}{\frac{1}{3}x^{-2/3}} && \text{(l'Hop)} \\ &= \lim_{x \rightarrow \infty} 3x^{-1/3} \\ &= 0 \end{aligned}$$

We conclude that  $\ln x$  grows more slowly as  $x$  approaches infinity than  $x^{1/3}$  or any positive power of  $x$ . In other words,  $\ln x$  increases very slowly.

**Question:** When we discussed extensions of l'Hôpital's rule, we learned that we're allowed to change some hypotheses. How many hypotheses can we change at once?

**Answer:** We can make any or all of the three changes listed. However,  $\frac{f(a)}{g(a)}$  must always be of the form  $\frac{\infty}{\infty}$ ,  $-\frac{\infty}{\infty}$ , or  $\frac{0}{0}$ .

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18.01SC Single Variable Calculus  
Fall 2010

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