3.6 Derivatives of Logarithmic Functions

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Fact

- $$\frac{d}{dx}(\ln x) = \frac{1}{x}$$

- $$\frac{d}{dx}(\log_a x) = \frac{1}{x \ln a}$$

The chain rule

Fact

$$\frac{d}{dx}\ln g(x) = \frac{g'(x)}{g(x)}.$$
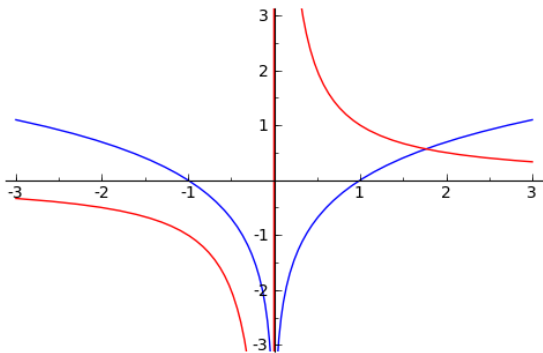
Examples

Example

Differentiate

- $y = \ln(\cos x)$
- $y = \sqrt[3]{\ln x}$.
- $y = x \ln(1 + e^x)$
- $y = \frac{1 + \ln x}{1 - \ln x}$

Example

Differentiate

$$y = \ln |x|.$$

Fact (Steps in Logarithmic differentiation)

- *Take natural logarithms of both sides of an equation $y = f(x)$ and use the Laws of Logarithm to simplify*
- *Differentiate implicitly with respect to x*
- *Solve the resulting equation for y'.*

Example

- $y = \sqrt{x}e^{x^2}(x^2 + 1)^{10}$
- $y = x^x$
- $y = x^{\cos x}$
- $y = (\ln x)^{\sin x}$