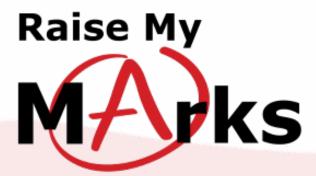
## Derivative of Logarithm Function



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## Derivative of the natural logarithm function

Let's start with  $y = \ln x$ . We know,

$$y = \ln x \Leftrightarrow e^y = x$$

Differentiating both sides we have,

$$y'e^{y} = 1$$
$$y' = \frac{1}{3}$$
$$= \frac{1}{x}$$

Therefore, we have,

If 
$$f(x) = \ln x \text{ then } f'(x) = \frac{1}{x}, \ x > 0.$$

In general,

$$f(x) = \ln(g(x)) \Rightarrow f'(x) = \frac{g'(x)}{g(x)}$$

Let's consider a more general logarithmic function with base b and a function g(x) in the exponent.

$$f(x) = b^{g(x)} \implies f'(x) = g'(x)b^{g(x)} \ln b$$

$$f(x) = b^x \implies f'(x) = b^x \ln b$$

$$y = \log_b x \implies \frac{dy}{dx} = \frac{1}{x \ln b}$$

$$y = \ln x \implies \frac{dy}{dx} = \frac{1}{x}$$

$$y = \log_b g(x) \implies \frac{dy}{dx} = \frac{g'(x)}{g(x) \ln b}$$

Therefore, we have,

$$y = \log_b g(x) \Rightarrow \frac{dy}{dx} = \frac{g'(x)}{g(x) \ln b}$$

## Exercises

Differentiate the following,

a) 
$$y = e^{x^2 \ln x}$$

$$f) f(x) = x \ln x - x$$

b) 
$$y = \ln(x^2 - 2x + 3)$$

g) 
$$y = x \ln\left(\frac{1}{x}\right)$$

c) 
$$y = \ln(4x^3 + x)$$

h) 
$$y = \ln(x^2 - 2x)$$

d) 
$$f(x) = \ln(\sqrt{5x - 7})$$

i) 
$$y = \frac{1}{\ln x}$$

e) 
$$f(x) = \frac{\ln x}{x}$$