DIFFERENTIATING NATURAL LOGARITHMIC FUNCTIONS:

$$\frac{d}{dx}\ln x = \frac{1}{x}$$

$$\frac{d}{dx}\ln f(x) = \frac{f'(x)}{f(x)} \text{ (applying chain rule)}$$

Product, quotient and chain rule also apply to logarithmic functions.

Product Rule: $\frac{d}{dx}[f(x)g(x)] = f'(x)g(x) + f(x)g'(x)$

Quotient Rule: $\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{g(x)f'(x) - f(x)g'(x)}{[g(x)]^2}$

Chain Rule: $\frac{d}{dx}[f(g(x))] = f'(g(x))g'(x)$

Common question types:

1. $\frac{d}{dx}A\ln x = \frac{A}{x}$
2. $\frac{d}{dx}A\ln Bx = \frac{AB}{Bx} = \frac{A}{x}$
3. $\frac{d}{dx}f(x)\ln x = f'(x)\ln x + \frac{f(x)}{x}$

5.1 WORKED EXAMPLE

Derive the following formula (hint: use chain rule!)

$$\frac{d}{dx}\ln f(x) = \frac{f'(x)}{f(x)}$$

5.2 WORKED EXAMPLE

Differentiate $\ln 3x$ with respect to x: