Derivatives of the Elementary Functions

Derivative of function $y = f(x)$ denoted as $f'(x)$ or $\frac{dy}{dx}$, where x is an independent variable.

Derivatives $f'(x)$ of the elementary functions $f(x)$

$f(x)$	$f'(x)$
$a = const$	0
x	1
ax	a
x^{α}	$\alpha x^{\alpha-1}$
x^2	$2x$
$\sqrt{x}$	$\frac{1}{2\sqrt{x}}$
$\frac{1}{x}$	$-\frac{1}{x^2}$
e^x	e^x
$\ln(x)$	$\frac{1}{x}$
$\sin(x)$	$\cos(x)$
$\cos(x)$	$-\sin(x)$
$\tan(x)$	$\frac{1}{\cos^2(x)}$

Rules of Differentiation

The sum rule:

$$\left(f(x)+g(x)\right)' = f'(x)+g'(x)$$

$$\left(f(x)-g(x)\right)' = f'(x)-g'(x)$$

The product rule:

$$\left(f(x)g(x)\right)' = f'(x)g(x)+f(x)g'(x)$$

The quotient rule:

$$\left(\frac{f(x)}{g(x)}\right)' = \frac{f'(x)g(x)-f(x)g'(x)}{g^2(x)},\ g(x)\neq 0$$

The chain rule (differentiation of a composition):

$$(f(g(x)))' = f'(g(x))g'(x)$$

Higher derivatives

Let *f(x)* be a function, and *f'(x)* its first derivative. The derivative of *f'(x)* is denoted as *f''(x)* and is called the second derivative of *f(x).* Similarly, the derivative of a second derivative is denoted as *f'''(x)* and is called the third derivative of *f(x)*. These repeated derivatives are called higher-order derivatives.

		Equivalent Notation
Function	$f(x)$	$y = f(x)$
First Derivative	$f'(x)$	$\frac{dy}{dx}$
Second Derivative	$f''(x) = (f'(x))'$	$\frac{d^2y}{dx^2} = \frac{d}{dx}\left(\frac{dy}{dx}\right)$
Third Derivative	$f'''(x) = (f''(x))'$	$\frac{d^3y}{dx^3} = \frac{d}{dx}\left(\frac{d^2y}{dx^2}\right)$