Derivatives

If $y = f(x)$, then the derivative is defined as

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

Basic Properties & Formulas

$f(x)$ and $g(x)$ are differentiable functions (there derivative exists), c and n are any real numbers, f', g' are derivatives of f and$g$ with respect to x.
Equivalent notations for derivative $f'(x) = y' = \frac{df}{dx} = \frac{dy}{dx} = \frac{d}{dx}(f(x)) = Df(x)$

1. $\left(cf(x)\right)' = cf'(x)$
2. $\left(f(x) \pm g(x)\right)' = f'(x) \pm g'(x)$
3. $\frac{d}{dx}(fg) = fg' + gf'$ $\Rightarrow$ Product Rule
4. $\frac{d}{dx}\left(\frac{f}{g}\right) = \frac{gf' - fg'}{g^2}$ $\Rightarrow$ Quotient Rule
5. $\frac{d}{dx}\left(f(g(x))\right) = f'\left(g(x)\right)g'(x)$, In Leibniz notation $\frac{d}{dx}(y) = \frac{d}{du}(y) \times \frac{d}{dx}(u)$ $\Rightarrow$ Chain Rule
6. $\frac{d}{dx}(x^n) = nx^{n-1}$
7. $\frac{d}{dx}(c) = 0$
8. $\frac{d}{dx}(x) = 1$
9. $\frac{d}{dx}(\sin x) = \cos x$
10. $\frac{d}{dx}(\cos x) = -\sin x$
11. $\frac{d}{dx}(\tan x) = \sec^2 x$
12. $\frac{d}{dx}(\sec x) = \sec x \tan x$
13. $\frac{d}{dx}(\csc x) = -\csc x \cot x$
14. $\frac{d}{dx}(\cot x) = -\csc^2 x$
15. $\frac{d}{dx}\left(\sin^{-1} x\right) = \frac{1}{\sqrt{1 - x^2}}$

16. $\frac{\mathrm{d}}{\mathrm{d}x}\left(\cos^{-1}x\right) = \frac{-1}{\sqrt{1-x^2}}$

17. $\frac{\mathrm{d}}{\mathrm{d}x}\left(\tan^{-1}x\right) = \frac{1}{1+x^2}$

18. $\frac{\mathrm{d}}{\mathrm{d}x}\left(\csc^{-1}x\right) = \frac{-1}{x\sqrt{x^2-1}}$

19. $\frac{\mathrm{d}}{\mathrm{d}x}\left(\sec^{-1}x\right) = \frac{-1}{x\sqrt{x^2-1}}$

20. $\frac{\mathrm{d}}{\mathrm{d}x}\left(\cot^{-1}x\right) = \frac{-1}{1+x^2}$

21. $\frac{\mathrm{d}}{\mathrm{d}x}\left(e^x\right) = e^x$

22. $\frac{\mathrm{d}}{\mathrm{d}x}\left(\log x\right) = \frac{1}{x}$

23. $\frac{\mathrm{d}}{\mathrm{d}x}\left(a^x\right) = a^x \log a$