General Derivative Rules

1. Definition	$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$
2. Constant Rule	$\frac{d}{dx}[c] = 0$
3. Constant Multiple Rule	$\frac{d}{dx}[cf(x)] = cf'(x)$
4. Sum Rule	$\frac{d}{dx}[f(x) + g(x)] = f'(x) + g'(x)$
5. Difference Rule	$\frac{d}{dx}[f(x) - g(x)] = f'(x) - g'(x)$
6. Product Rule	$\frac{d}{dx}[f(x)g(x)] = f'(x)g(x) + f(x)g'(x)$
7. Quotient Rule	$\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{g(x)f'(x) - f(x)g'(x)}{[g(x)]^2}$
8. Chain Rule	$\frac{d}{dx}[f(g(x))] = f'(g(x))g'(x)$

Derivative Rules for Particular Functions

	Basic Rule	**Chain Rule Form**
1. Powers	$\frac{d}{dx}[x^n] = nx^{n-1}$	$\frac{d}{dx}[(f(x))^n] = n(f(x))^{n-1}f'(x)$
2. Sine	$\frac{d}{dx}[\sin x] = \cos x$	$\frac{d}{dx}[\sin(f(x))] = \cos(f(x))f'(x)$
3. Cosine	$\frac{d}{dx}[\cos x] = -\sin x$	$\frac{d}{dx}[\cos(f(x))] = -\sin(f(x))f'(x)$
4. Tangent	$\frac{d}{dx}[\tan x] = \sec^2 x$	$\frac{d}{dx}[\tan(f(x))] = \sec^2(f(x))f'(x)$
5. Secant	$\frac{d}{dx}[\sec x] = \sec x \tan x$	$\frac{d}{dx}[\sec(f(x))] = \sec(f(x))\tan(f(x))f'(x)$
6. Cosecant	$\frac{d}{dx}[\csc x] = -\csc x \cot x$	$\frac{d}{dx}[\csc(f(x))] = -\csc(f(x))\cot(f(x))f'(x)$
7. Cotangent	$\frac{d}{dx}[\cot x] = -\csc^2 x$	$\frac{d}{dx}[\cot(f(x))] = -\csc^2(f(x))f'(x)$
8. Exponential (base e)	$\frac{d}{dx}[e^x] = e^x$	$\frac{d}{dx}\left[e^{(f(x))}\right] = e^{(f(x))}f'(x)$
9. Exponential (base a)	$\frac{d}{dx}[a^x] = a^x \ln a$	$\frac{d}{dx}\left[a^{f(x)}\right] = a^{f(x)} \ln a\, f'(x)$
10. Natural Logarithm	$\frac{d}{dx}[\ln x] = \frac{1}{x}$	$\frac{d}{dx}[\ln f(x)] = \frac{1}{f(x)}f'(x)$
11. Logarithm (base a)	$\frac{d}{dx}[\log_a x] = \frac{1}{x \ln a}$	$\frac{d}{dx}[\log_a f(x)] = \frac{1}{f(x)\ln a}f'(x)$

General Antiderivative Rules

Let $F(x)$ be any antiderivative of $f(x)$. That is, $F'(x) = f(x)$. The **most general antiderivative** of $f(x)$ is then $F(x) + C$ where C is an arbitrary constant.

	Original Function	**General Antiderivative**
1. Constant Rule	c (a constant)	$cx + C$
2. Constant Multiple Rule	$cf(x)$	$cF(x) + C$
3. Sum Rule	$f(x) + g(x)$	$F(x) + G(x) + C$
4. Difference Rule	$f(x) - g(x)$	$F(x) - G(x) + C$

Antiderivative Rules for Particular Functions

	Original Function	**General Antiderivative**
1. Powers ($n \neq -1$)	$f(x) = x^n$	$F(x) = \frac{x^{n+1}}{n+1} + C$
2. Power ($n = -1$)	$f(x) = \frac{1}{x}$	$F(x) = \ln\|x\| + C$
3. Sine	$f(x) = \sin x$	$F(x) = -\cos x + C$
4. Cosine	$f(x) = \cos x$	$F(x) = \sin x + C$
5. Tangent	$f(x) = \sec^2 x$	$F(x) = \tan x + C$
6. Secant	$f(x) = \sec x \tan x$	$F(x) = \sec x + C$
7. Cosecant	$f(x) = \csc x \cot x$	$F(x) = -\csc x + C$
8. Cotangent	$f(x) = \csc^2 x$	$F(x) = -\cot x + C$
9. Exponential (base e)	$f(x) = e^x$	$F(x) = e^x + C$
10. Exponential (base a)	$f(x) = a^x$	$F(x) = \frac{a^x}{\ln a} + C$