Calculus I: Derivative Rules (Differentiation) Formula Sheet

Core Calc I rules

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1) Basic Facts & Notation

- **Derivative (definition):**
$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$
- **Leibniz notation:** $f'(x) = \dfrac{dy}{dx}$ when $y = f(x)$.
- **Higher derivatives:** $f''(x)$, $f^{(3)}(x)$, …, $f^{(n)}(x)$.

2) Core Differentiation Rules (Calc I Essentials)

Let $u = u(x)$, $v = v(x)$, c constant.

Rule	Formula
Constant Rule	$\dfrac{d}{dx}[c] = 0$
Power Rule	$\dfrac{d}{dx}[x^n] = nx^{n-1}$ (for any real n where defined)
Constant Multiple	$\dfrac{d}{dx}[c\,u] = c\,u'$
Sum/Difference	$\dfrac{d}{dx}[u \pm v] = u' \pm v'$
Product Rule	$\dfrac{d}{dx}[uv] = u'v + uv'$
Quotient Rule	$\dfrac{d}{dx}\left[\dfrac{u}{v}\right] = \dfrac{u'v - uv'}{v^2}$, $v \neq 0$
Chain Rule	$\dfrac{d}{dx}[f(g(x))] = f'(g(x))\,g'(x)$

3) Common Derivatives (Core Table)

A) Algebraic / Root Forms

$$\frac{d}{dx}[x^n] = nx^{n-1}, \qquad \frac{d}{dx}\left[\sqrt{x}\right] = \frac{1}{2\sqrt{x}}, \qquad \frac{d}{dx}\left[\frac{1}{x}\right] = -\frac{1}{x^2}$$

B) Exponential & Logarithmic

Function	Derivative
e^x	e^x
$a^x \ (a > 0, a \neq 1)$	$a^x \ln(a)$
$\ln(x)$	$\dfrac{1}{x}$
$\log_a(x)$	$\dfrac{1}{x \ln(a)}$
$\ln \lvert u \rvert$	$\dfrac{u'}{u}$
e^u	$e^u \, u'$
a^u	$a^u \ln(a) \, u'$

C) Trigonometric

Function	Derivative
$\sin x$	$\cos x$
$\cos x$	$-\sin x$
$\tan x$	$\sec^2 x$
$\cot x$	$-\csc^2 x$
$\sec x$	$\sec x \tan x$
$\csc x$	$-\csc x \cot x$