MATHIGH

AP Calculus AB Formula Sheet

Limits & Continuity

Topic	Formula/Rule
Limit Laws	$\lim_{x \to c} [f(x) \pm g(x)] = \lim_{x \to c} f(x) \pm \lim_{x \to c} g(x)$ $\lim_{x \to c} [f(x) \cdot g(x)] = \lim_{x \to c} f(x) \cdot \lim_{x \to c} g(x)$
Indeterminate Forms	Use **L'Hôpital's Rule** for $\frac{0}{0}$ or $\frac{\infty}{\infty}$ form $\lim_{x \to c} \frac{f(x)}{g(x)} = \lim_{x \to c} \frac{f'(x)}{g'(x)}$
Continuity Condition	$f(x)$ is continuous at $x = c$ if: 1. $f(c)$ is defined 2. $\lim_{x \to c} f(x)$ exists 3. $\lim_{x \to c} f(x) = f(c)$
Discontinuities	**Removable:** Hole in the graph (factor cancellation). **Jump:** Left and right limits are different (piecewise). **Infinite:** Vertical asymptote.
Intermediate Value Thm (IVT)	If f is continuous on $[a,b]$, then for every value k between $f(a)$ and $f(b)$ there exists at least one c in (a,b) such that $f(c) = k$.

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Derivative Rules & Techniques

Topic	Formula/Rule
Power Rule	$\frac{d}{dx}[u^n] = nu^{n-1} \cdot u'$
Product Rule	$\frac{d}{dx}[u \cdot v] = u'v + uv'$
Quotient Rule	$\frac{d}{dx}\left[\frac{u}{v}\right] = \frac{u'v - uv'}{v^2}$
Chain Rule	$\frac{d}{dx}[f(g(x))] = f'(g(x)) \cdot g'(x)$
Implicit Differentiation	Differentiate all terms w.r.t x. For y terms, multiply by $\frac{dy}{dx}$. Solve for $\frac{dy}{dx}$.
Derivative of Inverse Function	$\frac{d}{dx}[f^{-1}(x)] = \frac{1}{f'(f^{-1}(x))}$
Parametric Derivative	$\frac{dy}{dx} = \frac{dy/dt}{dx/dt}$

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Exponential, Logarithmic & Trig Derivatives

Function	Derivative	Function	Derivative
$\ln u$	$\frac{u'}{u}$	$\arcsin u$	$\frac{u'}{\sqrt{1-u^2}}$
e^u	e^u	$\arccos u$	$\frac{-u'}{\sqrt{1-u^2}}$
a^u	$a^u \cdot u' \cdot \ln a$	$\arctan u$	$\frac{u'}{1+u^2}$
$\sin u$	$u' \cdot \cos u$	$\sec u$	$\sec u \cdot \tan u \cdot u'$
$\cos u$	$-u' \cdot \sin u$	$\csc u$	$-\csc u \cdot \cot u \cdot u'$
$\tan u$	$u' \cdot \sec^2 u,\ u'(1+\tan^2 u)$	$\cot u$	$-\csc^2 u \cdot u'$

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First & Second Derivative Tests

Concept	Formula/Rule
Monotonicity (Increasing/Decreasing)	$f'(x) > 0 \Rightarrow \text{increasing}$
	$f'(x) < 0 \Rightarrow \text{decreasing}$
Critical Points	Occur where $f'(x) = 0$ or $f'(x)$ is undefined.
First Derivative Test	$f'(x)$ changes $(+)$ to $(-)$ $\Rightarrow$ Local Max
	$f'(x)$ changes $(-)$ to $(+)$ $\Rightarrow$ Local Min
Concavity	$f''(x) > 0 \Rightarrow \text{Concave Up}$
	$f''(x) < 0 \Rightarrow \text{Concave Down}$
	Inflection Points occur where $f''(x)$ changes sign.
Second Derivative Test	If $f'(c) = 0 : f''(c) > 0 \Rightarrow \text{Local Min}$
	If $f'(c) = 0 : f''(c) < 0 \Rightarrow \text{Local Max}$
Absolute Extrema	On a closed interval $[a, b]$, test all critical points and endpoints for max/min.

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Integrals & Fundamental Theorem of Calculus

Topic	Formula/Rule
Power Rule (Integral)	$\int x^n\,dx = \frac{x^{n+1}}{n+1} + C,\ n \neq -1$
Logarithmic Integral	$\int \frac{1}{x}\,dx = \ln\lvert x\rvert + C$
Exponential Integral	$\int e^x\,dx = e^x + C$
u-Substitution	Let $u = g(x)$, then $\int f(g(x))\,g'(x)\,dx = \int f(u)\,du$
FTC Part 1 (Net Change)	$\int_a^b f'(x)\,dx = f(b) - f(a)$
FTC Part 2 (Derivative of Integral)	$\frac{d}{dx}\left[\int_a^{g(x)} f(t)\,dt\right] = f(g(x)) \cdot g'(x)$
Average Value of a Function	$f_{avg} = \frac{1}{b-a}\int_a^b f(x)\,dx$

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Motion Models & Trig Identities

Concept	Formula
Velocity & Acceleration	$v(t) = s'(t), \quad a(t) = v'(t)$
Net Displacement	$\int_{t_1}^{t_2} v(t)\,dt$
Total Distance Traveled	$\int_{t_1}^{t_2} \lvert v(t) \rvert\,dt$
Change in Direction	Occurs when $v(t)$ changes sign
Trig Identities	$\sin^2 x + \cos^2 x = 1$
	$1 + \tan^2 x = \sec^2 x$
	$1 + \cot^2 x = \csc^2 x$
Common Trig Integrals	$\int \sin x\,dx = -\cos x + C$
	$\int \cos x\,dx = \sin x + C$
	$\int \sec^2 x\,dx = \tan x + C$
	$\int \csc^2 x\,dx = -\cot x + C$

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