

AP CALC AB FORMULA STUDY GUIDE

Properties of Limits

$$\lim_{x \rightarrow a} [f(x) + g(x)] = \lim_{x \rightarrow a} f(x) + \lim_{x \rightarrow a} g(x)$$

$$\lim_{x \rightarrow a} [f(x) - g(x)] = \lim_{x \rightarrow a} f(x) - \lim_{x \rightarrow a} g(x)$$

$$\lim_{x \rightarrow a} [c \cdot f(x)] = c \lim_{x \rightarrow a} f(x)$$

$$\lim_{x \rightarrow a} [f(x)g(x)] = \lim_{x \rightarrow a} f(x) \cdot \lim_{x \rightarrow a} g(x)$$

$$\lim_{x \rightarrow a} \frac{f(x)}{g(x)} = \frac{\lim_{x \rightarrow a} f(x)}{\lim_{x \rightarrow a} g(x)} \quad \text{if } \lim_{x \rightarrow a} g(x) \neq 0$$

$$\lim_{x \rightarrow a} [f(x)]^n = \left[\lim_{x \rightarrow a} f(x) \right]^n$$

$$\lim_{x \rightarrow a} \sqrt[n]{f(x)} = \sqrt[n]{\lim_{x \rightarrow a} f(x)}$$

Direct Substitution Property
If f is a polynomial or a rational function and a is in the domain of f , then $\lim_{x \rightarrow a} f(x) = f(a)$.

Theorems

$$\lim_{x \rightarrow 0} \frac{\sin x}{x} = 1 \quad \lim_{x \rightarrow 0} \frac{\cos x - 1}{x} = 0$$

$$\lim_{x \rightarrow a} f(g(x)) = f(\lim_{x \rightarrow a} g(x))$$

The Squeeze Theorem

Given $f(x) \leq g(x) \leq h(x)$ for values of x near a , except possibly at a . If $\lim_{x \rightarrow a} f(x) = \lim_{x \rightarrow a} h(x) = L$,

then $\lim_{x \rightarrow a} g(x) = L$.



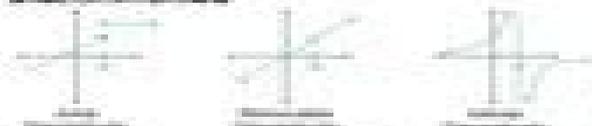
Continuity

f is continuous at a number a , if (1) $f(a)$ is defined

(2) $\lim_{x \rightarrow a} f(x)$ exists

(3) $\lim_{x \rightarrow a} f(x) = f(a)$

Discontinuities



Vertical Asymptote(s) of f

The line $x = a$ is a vertical asymptote of $y = f(x)$ if at least one of the following statements is true:

$$\lim_{x \rightarrow a^-} f(x) = \pm\infty \quad \lim_{x \rightarrow a^+} f(x) = \pm\infty$$

$$\lim_{x \rightarrow a^-} f(x) = \pm\infty \quad \lim_{x \rightarrow a^+} f(x) = \pm\infty$$

$$\lim_{x \rightarrow a^-} f(x) = \pm\infty \quad \lim_{x \rightarrow a^+} f(x) = \pm\infty$$

Infinite Limits

$$\lim_{x \rightarrow a} \frac{f(x)}{g(x)}$$

- if $f(x)$ grows faster, the limit is $\pm\infty$
- if $g(x)$ grows faster, the limit is 0
- if $f(x) \neq 0$ & $g(x) \neq 0$ are polynomials with the same degree, the limit equals the ratio of their leading coefficients

Horizontal Asymptote(s) of f

$$y = \lim_{x \rightarrow \pm\infty} f(x) \quad \text{or} \quad y = \lim_{x \rightarrow \pm\infty} f(x)$$

Intermediate Value Theorem

If f is continuous on $[a, b]$ and M is any number between $f(a)$ and $f(b)$, then there is at least one number c in $[a, b]$ such that $f(c) = M$.



Average Rate of Change of a function $f(x)$ over closed interval $[a, b]$ is

$$\frac{f(b) - f(a)}{b - a}$$

Definition of a Derivative

$$f'(a) = \lim_{h \rightarrow 0} \frac{f(a+h) - f(a)}{h}$$

$$f'(a) = \lim_{x \rightarrow a} \frac{f(x) - f(a)}{x - a}$$

Not Differentiable



Corner

Corner

Vertical Tangent

Differentiation Rules

$$\frac{d}{dx}(c) = 0$$

$$\frac{d}{dx}[c \cdot f(x)] = c \frac{d}{dx}[f(x)]$$

$$\frac{d}{dx}[f(x) + g(x)] = \frac{d}{dx}f(x) + \frac{d}{dx}g(x)$$

$$\frac{d}{dx}[f(x) - g(x)] = \frac{d}{dx}f(x) - \frac{d}{dx}g(x)$$

Derivatives

$$\frac{d}{dx}(x^n) = nx^{n-1} \quad \frac{d}{dx}(\sin x) = \cos x$$

$$\frac{d}{dx}(x^n) = x^n \quad \frac{d}{dx}(\cos x) = -\sin x$$

$$\frac{d}{dx}(e^x) = e^x \quad \frac{d}{dx}(\tan x) = \sec^2 x$$

$$\frac{d}{dx}(\ln x) = \frac{1}{x}$$

Derivatives of Inverse

$$\frac{d}{dx}(\sin^{-1} x) = \frac{1}{\sqrt{1-x^2}}$$

$$\frac{d}{dx}(\cos^{-1} x) = \frac{-1}{\sqrt{1-x^2}}$$

$$\frac{d}{dx}(\tan^{-1} x) = \frac{1}{1+x^2}$$

$$\frac{d}{dx}(f^{-1}(x)) = \frac{1}{f'(f^{-1}(x))}$$

Product Rule

$$\frac{d}{dx}(f(x)g(x)) = f'(x)g(x) + f(x)g'(x)$$

Quotient Rule

$$\frac{d}{dx}\left(\frac{f(x)}{g(x)}\right) = \frac{f'(x)g(x) - f(x)g'(x)}{(g(x))^2}$$

Chain Rule

$$\frac{d}{dx}f(g(x)) = f'(g(x))g'(x)$$

Linear Approximation of f at point a

Line approximation of f at a is

$$L(x) = f(a) + f'(a)(x - a)$$

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William Ma



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