

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:

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

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

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

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

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

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

Indefinite Limits

$$\lim_{x \rightarrow \infty} f(x) = L$$

- if $f(x)$ grows faster, the limit is ∞
- if $f(x)$ approaches faster, the limit is 0
- if $f(x) = p(x)$ & $q(x) = r(x)$ are polynomials with the same degree, the limit equals the ratio of their leading coefficients.

Horizontal Asymptote(s) of f

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

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

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

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

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

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

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

Line approximation of f at a is

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

Ap Calculus Exam Study Guide

N Colangelo



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web jan 1 2000 powell describes displacement chromatography and elution chromatography as the two principal methods for separating lanthanide cations by ion exchange chromatography in displacement chromatography the ions to be separated are first sorbed onto a column of the resin the analyte metals are eluted from the column

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web feb 4 2021 the lanthanides are located on the top row of the two rows of elements found below the main body of the periodic table placing the lanthanides and the actinides the row below the lanthanides below the other elements is just a matter of aesthetics the lanthanides belong to period 6 like cesium barium and hafnium