

AP CALC BC FORMULA STUDY GUIDE

Absolute Value

$$|x| = \begin{cases} -x, & \text{if } x < 0 \\ x, & \text{if } x \geq 0 \end{cases}$$

Even / Odd Function

evaluate $f(x)$ $f(-x) = f(x)$	f' is even	symmetric to $y = x$
$f(-x) = -f(x)$	odd	origin

Theorems

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

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

Horizontal Asymptote(s) of f

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

Infinite Limits

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

- if $f(x)$ grows faster, the limit = ∞
- if $g(x)$ grows faster, the limit = 0
- if $f(x)$ & $g(x)$ are polynomials with the same degree, the limit = the ratio of their leading coefficient to

Continuity

f is continuous at a number a , if

(1) $f(a)$ is defined

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

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

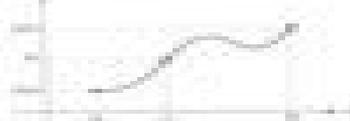
Intermediate Value Theorem

If f is continuous on $[a, b]$ and f is arbitrary 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

$$\text{interval } [a, b] \text{ is } \frac{f(b) - f(a)}{b - a}$$

Chain Rule

Definition of a Derivative

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

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

Derivatives

$$\frac{d}{dx} \sin(x) = \cos(x)$$

$$\frac{d}{dx} (e^x) = e^x$$

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

$$\frac{d}{dx} (e^{-x}) = -e^{-x}$$

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

$$\frac{d}{dx} (e^{ax}) = ae^{ax}$$

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

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

$$\frac{d}{dx} \ln(x^2) = \frac{1}{x}$$

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

$$\frac{d}{dx} (e^{-x}) = -e^{-x}$$

$$\frac{d}{dx} (e^{-ax}) = -ae^{-ax}$$

Product Rule

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

Quotient Rule

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

Chain Rule

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

Linear Approximation / Tangent

Line approximation of f at a is

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

L'Hopital's Rule

$$\text{if } \lim_{x \rightarrow a} \frac{f(x)}{g(x)} = 0/0 \text{ or } \infty/\infty,$$

$$\text{then } \lim_{x \rightarrow a} \frac{f(x)}{g(x)} = \lim_{x \rightarrow a} \frac{f'(x)}{g'(x)}$$

Mean Value Theorem

if f is continuous on $[a, b]$ and

differentiable on (a, b) , then there

is a number c in (a, b) such that

$$f'(c) = \frac{f(b) - f(a)}{b - a}$$



Extreme Value Theorem

if f is continuous on $[a, b]$, then f has both a minimum and a maximum on the interval.

Critical Number

c is a critical number of f if either $f'(c)$ does not exist or $f'(c) = 0$.

Absolute minimum/maximum of f over a closed interval $[a, b]$

- (1) Find the critical values of f .
- (2) Plug critical values and endpoints into f to find the absolute min/max.

Increasing / Decreasing

Let f be continuous on $[a, b]$ and differentiable on (a, b) .

- if $f'(x) > 0$, f is increasing
- if $f'(x) < 0$, f is decreasing

First Derivative Test

Let c be a critical number of a

continuous function f .

- if $f'(x)$ changes from positive to negative at c , then f has a local maximum at c .
- if $f'(x)$ changes from negative to positive at c , then f has a local minimum at c .

Concavity

- if $f''(x) > 0$, f is concave up
- if $f''(x) < 0$, f is concave down

Point of Inflection

is where f is continuous and changes from concave up to concave down, or vice versa.

Second Derivative Test

if f has a critical value at c , $f'(c) = 0$, and

- if $f''(c) > 0$, then f has a local minimum at c .
- if $f''(c) < 0$, then f has a local maximum at c .

Particle motion at rest: $v(t) = 0$

Moving in positive direction

(right/backwards): $v(t) > 0$

Moving in negative direction

(left/forwards): $v(t) < 0$

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**David R. Arterburn, John Rast
Hubbard, Michael A. Perl**



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