

# 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 $f(x)$	$f'$ is	symmetric to
$f(-x) = f(x)$	even	$y = \text{axis}$
$f(-x) = -f(x)$	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 =  $\infty$
- 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 coefficients

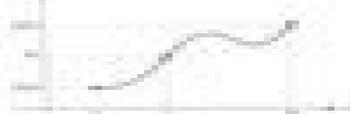
## Continuity

$f$  is continuous at a number  $a$ , if

- $f(a)$  is defined
- $\lim_{x \rightarrow a} f(x)$  exists
- $\lim_{x \rightarrow a} f(x) = f(a)$

## 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

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

## Chain Rule

## Definition of a Derivative

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

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

## Derivatives

$$\begin{aligned} \frac{d}{dx} \sin(x) &= \cos(x) & \frac{d}{dx} (e^x) &= e^x \\ \frac{d}{dx} \cos(x) &= -\sin(x) & \frac{d}{dx} (e^{-x}) &= -e^{-x} \\ \frac{d}{dx} \tan(x) &= \sec^2(x) & \frac{d}{dx} (a^x) &= a^x \ln a \\ \frac{d}{dx} \cot(x) &= -\csc^2(x) & \frac{d}{dx} (a^{-x}) &= -a^{-x} \ln a \\ \frac{d}{dx} \sec^{-1}(x) &= \frac{1}{\sqrt{1-x^2}} & \frac{d}{dx} (\ln x) &= \frac{1}{x} \\ \frac{d}{dx} \csc^{-1}(x) &= -\frac{1}{\sqrt{1-x^2}} & \frac{d}{dx} (\ln |x|) &= \frac{1}{x} \\ \frac{d}{dx} \tan^{-1}(x) &= \frac{1}{1+x^2} & \frac{d}{dx} (f \cdot g) &= f'g + g'f \end{aligned}$$

## Product Rule

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

## 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 / Tangent

Line approximation of  $f$  at  $a$  is

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

## 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 Min/Max/Maximum of  $f$  over a Closed Interval  $[a, b]$

- Find the critical values of  $f$
- 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/forward):  $v(t) > 0$

Moving in negative direction (left/backward):  $v(t) < 0$

# Calculus Bc Ap Study Guide

**RD Boyd**



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