

# 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
$f(-x) = f(x)$	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

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

- 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

(1)  $f(a)$  is defined

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

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

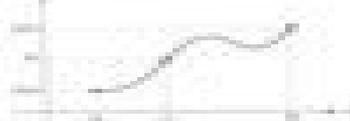
## Intermediate Value Theorem

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

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

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

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

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

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

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

$$\frac{d}{dx} \cot(x) = -\csc^2(x)$$

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

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

$$\frac{d}{dx} \csc(x) = -\csc(x)\cot(x)$$

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

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

## 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

$$\text{Line approximation of } f \text{ at } a \text{ is } L(x) = f'(a)(x-a) + f(a)$$

## L'Hopital's Rule

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

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

## 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  $[a, b]$

- 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:  $a(t) > 0$

Moving in negative direction:  $a(t) < 0$

Moving in positive direction:  $v(t) > 0$

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

# Calculus Bc Ap Study Guide

**Anthony S. Fauci**



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