Limits

2 Precise Definition of a Limit Let f be a function defined on some open interval that contains the number a, except possibly at a itself. Then we say that the **limit of $f(x)$ as x approaches a is L**, and we write

$$\lim_{x \to a} f(x) = L$$

if for every number $\varepsilon > 0$ there is a number $\delta > 0$ such that

$$\text{if} \quad 0 < |x - a| < \delta \quad \text{then} \quad |f(x) - L| < \varepsilon$$

One Sided Limits

Show that the side you are evaluating exists

If it is defined @ value plug it in

First/ Second Derivative Tests

First	Second
1. Take derivative and find *c.v.*	1. Take and find *c.v.*
2. Use a sign chart	2. Use a sign chart
+ is inc. / - is dec.	+ is CC up / - is CC down
shows extrema	shows inflection points
* test **endpoints**	*if checking extrema sign is the opposite

Area Between Curves

$$A = \int_a^b (f(x) - g(x))dx$$

$$A = \int_a^b (\text{top} - \text{bottom})dx$$

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Derivative of an Integral

$$\frac{d}{dx}\int_{g(x)}^{h(x)} f(t)\,dt = f(h(x))\,h'(x) - f(g(x))\,g'(x)$$

Limit Definition of Derivatives

$$\frac{dy}{dx} = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

$$m = \lim_{x \to a} \frac{f(x) - f(a)}{x - a}$$

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Power Rule

$$\frac{d}{dx}x^n = n \cdot x^{n-1}$$

Product/Quotient Rule

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

$$\frac{d}{dx}\left[(f(x))^n\right] = n(f(x))^{n-1} \cdot f'(x)$$

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

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Intermediate Value Theorem

IF f is a function that is continuous over the interval [a,b] and m is some number between f(a) and f(b), THEN there exists a number c between and b such that f(c)=m.

Mean Value Theorem

Let f be continuous on $[a, b]$ and differentiable on (a, b). Then there exists a point c in (a, b) such that

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

Rolle's Theorem

IF:	- [a,b] is continuous
	- (a,b) is differentiable
	- f(a)=f(b)
THEN:	f'(c)=0

Newton Raphson Method

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

Related Rates

1. Draw a picture and label
2. Use formula for area/volume of shape
3. Take derivative of formula
4. Plug in values to each formula as needed

*One variable will **NOT** have a rate of change (ex. ladder)