

AP CALCULUS
Stuff you **MUST** know Cold

* means topic only on BC

Curve sketching and analysis $y = f(x)$ must be continuous at each: critical point: $\frac{dy}{dx} = 0$ or undefined local minimum: (and look out for endpoints) $\frac{dy}{dx}$ goes $(-, 0, +)$ or $(-, \text{und}, +)$ or $\frac{d^2y}{dx^2} > 0$ local maximum: $\frac{dy}{dx}$ goes $(+, 0, -)$ or $(+, \text{und}, -)$ or $\frac{d^2y}{dx^2} < 0$ point of inflection: concavity changes $\frac{d^2y}{dx^2}$ goes from $(+, 0, -)$, $(-, 0, +)$, $(+, \text{und}, -)$, or $(-, \text{und}, +)$	Differentiation Rules Chain Rule $\frac{d}{dx}[f(u)] = f'(u) \frac{du}{dx}$ OR $\frac{dy}{dx} = \frac{dy}{du} \frac{du}{dx}$ Product Rule $\frac{d}{dx}(uv) = \frac{du}{dx}v + u \frac{dv}{dx}$ OR $u'v + uv'$ Quotient Rule $\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{\frac{du}{dx}v - u \frac{dv}{dx}}{v^2}$ OR $\frac{u'v - uv'}{v^2}$	Approx. Methods for Integration Trapezoidal Rule $\int_a^b f(x) dx \approx \frac{1}{2} \Delta x [f(x_0) + 2f(x_1) + \dots + 2f(x_{n-1}) + f(x_n)]$ With data, do each trap separately using $\frac{1}{2} \Delta x (f(x_1) + f(x_2))$. It is an over approximation if $f''(x) > 0$ (concave up) Riemann Sums are rectangles. Left Riemann sums under approximate when $f(x)$ is increasing ($f'(x) > 0$),...
Basic Derivatives $\frac{d}{dx}(x^n) = nx^{n-1}$ $\frac{d}{dx}(\sin x) = \cos x$ $\frac{d}{dx}(\cos x) = -\sin x$ $\frac{d}{dx}(\tan x) = \sec^2 x$ $\frac{d}{dx}(\cot x) = -\csc^2 x$ $\frac{d}{dx}(\sec x) = \sec x \tan x$ $\frac{d}{dx}(\csc x) = -\csc x \cot x$ $\frac{d}{dx}(\ln u) = \frac{1}{u} \frac{du}{dx}$ $\frac{d}{dx}(e^u) = e^u \frac{du}{dx}$ where u is a function of x, and a is a constant.	“PLUS A CONSTANT” The Fundamental Theorem of Calculus $\int_a^b f(x) dx = F(b) - F(a)$ where $F'(x) = f(x)$ Corollary to FTC $\frac{d}{dx} \int_{a(x)}^{b(x)} f(x) dx = f(b(x))b'(x) - f(a(x))a'(x)$ Intermediate Value Theorem If the function $f(x)$ is continuous on $[a, b]$, and y is a number between $f(a)$ and $f(b)$, then there exists at least one number $x = c$ in the open interval (a, b) such that $f(c) = y$.	Theorem of the Mean Value ie. AVERAGE VALUE If the function $f(x)$ is continuous on $[a, b]$ and the first derivative exists on the interval (a, b), then there exists a number $x = c$ on (a, b) such that $f'(c) = \frac{\int_a^b f(x) dx}{(b-a)}$ This value $f'(c)$ is the “average value” of the function on the interval $[a, b]$. Solids of Revolution and friends Disk Method $V = \pi \int_a^b [R(x)]^2 dx$ Washer Method $V = \pi \int_a^b ([R(x)]^2 - [r(x)]^2) dx$ General volume equation (not rotated) $V = \int_a^b Area(x) dx$ *Arc Length $L = \int_a^b \sqrt{1 + [f'(x)]^2} dx$ $= \int_a^b \sqrt{[x'(t)]^2 + [y'(t)]^2} dt$
More Derivatives $\frac{d}{dx}\left(\sin^{-1} \frac{u}{a}\right) = \frac{1}{\sqrt{a^2 - u^2}} \frac{du}{dx}$ $\frac{d}{dx}\left(\cos^{-1} x\right) = \frac{-1}{\sqrt{1-x^2}}$ $\frac{d}{dx}\left(\tan^{-1} \frac{u}{a}\right) = \frac{a}{a^2 + u^2} \frac{du}{dx}$ $\frac{d}{dx}\left(\cot^{-1} x\right) = \frac{-1}{1+x^2}$ $\frac{d}{dx}\left(\sec^{-1} \frac{u}{a}\right) = \frac{a}{ u \sqrt{u^2 - a^2}} \frac{du}{dx}$ $\frac{d}{dx}(\csc^{-1} x) = \frac{-1}{ x \sqrt{x^2 - 1}}$ $\frac{d}{dx}(a^{u(x)}) = a^{u(x)} \ln a \cdot \frac{du}{dx}$ $\frac{d}{dx}(\log_e x) = \frac{1}{x \ln a}$	Mean Value Theorem If the function $f(x)$ is continuous on $[a, b]$, AND the first derivative exists on the interval (a, b), then there is at least one number $x = c$ in (a, b) such that $f'(c) = \frac{f(b) - f(a)}{b - a}$ Rolle's Theorem If the function $f(x)$ is continuous on $[a, b]$, AND the first derivative exists on the interval (a, b), AND $f(a) = f(b)$, then there is at least one number $x = c$ in (a, b) such that $f'(c) = 0$. Derivative Formula for Inverses $\left. \frac{df^{-1}}{dx} \right _{x=f(a)} = \frac{1}{\left. \frac{df}{dx} \right _{x=a}}$	Distance, Velocity, and Acceleration velocity = $\frac{d}{dt}$ (position) acceleration = $\frac{d}{dt}$ (velocity) *velocity vector = $\left\langle \frac{dx}{dt}, \frac{dy}{dt} \right\rangle$ speed = $v = \sqrt{(x')^2 + (y')^2}$ * displacement = $\int_a^b v dt$ distance = $\int_{t=a}^{t=b} v dt$ $\int_a^b \sqrt{(x')^2 + (y')^2} dt$ * average velocity = $= \frac{\text{final position} - \text{initial position}}{\text{total time}}$ $= \frac{\Delta x}{\Delta t}$

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Xiaolong Qi



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