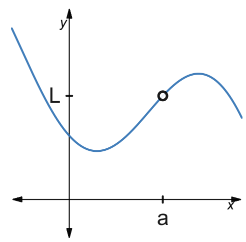
Limits, Continuity, Differentiability Evaluate $\lim_{x \to a} f(x)$	Limits, Continuity, Differentiability $\lim_{x \to \infty} f(x)$ means
Limits, Continuity, Differentiability $\lim_{x \to a} f(x)$ exists if	Limits, Continuity, Differentiability $f(x)$ is continuous at $x = a$ if
Limits, Continuity, Differentiability $f(x)$ is differentiable at $x = a$ if	Limits, Continuity, Differentiability L'hôspital's Rule
Derivatives Limit definition of $f'(a)$ (Derivative at the point $x = a$)	Derivatives Limit definition of $f'(x)$ (Equation of derivative function)
Derivatives $\frac{d}{dx}(c)$	Derivatives $\frac{d}{dx}(x^n)$

Find end behavior. Use TFEPLC and rational function rules comparing the degree of the numerator and denominator.	Simplify. Let $x = a$. (Direct substitution)
$\lim_{x\to a^-} f(x) = \lim_{x\to a^+} f(x)$ and $\lim_{x\to a} f(x) = f(a)$	$\lim_{x\to a^-} f(x) = \lim_{x\to a^+} f(x)$ 
If $\lim_{x\to a} \frac{f(x)}{g(x)}$ is indeterminate $\left(\frac{0}{0} \text{ or } \frac{\infty}{\infty}\right)$ Then $\lim_{x\to a} \frac{f(x)}{g(x)} = \lim_{x\to a} \frac{f'(x)}{g'(x)}$	$f(x)$ is continuous at $x = a$ and $\lim_{x\to a^-} f'(x) = \lim_{x\to a^+} f'(x)$
$\lim_{h\to 0} \frac{f(x+h) - f(x)}{h}$	$\lim_{x\to a} \frac{f(x)-f(a)}{x-a}$ or $\lim_{h\to 0} \frac{f(a+h) - f(a)}{h}$
nx^{n-1}	0

Derivatives $\frac{d}{dx}(c(f(x))$	Derivatives Product Rule $\frac{d}{dx}(f(x) \cdot g(x))$
Derivatives Quotient Rule $\frac{d}{dx}\left(\frac{f(x)}{g(x)}\right)$	Derivatives Chain Rule – Derivative of a composite function $\frac{d}{dx}(f(g(x))$
Derivatives $\frac{d}{dx}(\sin x)$	Derivatives $\frac{d}{dx}(\cos x)$
Derivatives $\frac{d}{dx}(\tan x)$	Derivatives $\frac{d}{dx}(\cot x)$
Derivatives $\frac{d}{dx}(\sec x)$	Derivatives $\frac{d}{dx}(\csc x)$

$f(x)g'(x) + g(x)f'(x)$	$c \cdot f'(x)$
$g'(x) \cdot f'(g(x))$	$\dfrac{g(x) \cdot f'(x) - f(x)g'(x)}{\left(g(x)\right)^2}$
$-\sin x$	$\cos x$
$-\csc^2 x$	$\sec^2 x$
$-\csc x \cot x$	$\sec x \tan x$

Derivatives $$\frac{d}{dx}(\ln x)$$	Derivatives $$\frac{d}{dx}(e^x)$$
Derivatives $$\frac{d}{dx}(a^x)$$	Derivatives $$\frac{d}{dx}(\sin^{-1} x)$$
Derivatives $$\frac{d}{dx}(\tan^{-1} x)$$	Derivatives Very rare! $$\frac{d}{dx}(\sec^{-1} x)$$
Derivatives Derivatives of inverse cofunctions $(\arccos x, \operatorname{arccot} x, \operatorname{arccsc} x)$	Derivatives Derivatives of inverse functions Let $g(x) = f^{-1}(x)$ What is $g'(x)$?
Derivatives $$\frac{d}{dx}(\lvert x \rvert)$$	Derivatives Implicit differentiation

e^x	$\frac{1}{x}$
$\frac{1}{\sqrt{1-x^2}}$	$a^x \cdot \ln a$
$\frac{1}{\lvert x\rvert\sqrt{x^2-1}}$	$\frac{1}{1+x^2}$
$g'(x) = \frac{1}{f'(g(x))}$ Slopes at inverse points are reciprocals.	Opposite of the derivative of the corresponding function
Differentiate both sides with respect to x. Treat y as a function of x and apply chain rule.	Find the slope using the graph. There is no shortcut rule for this function!

Other Average rate of change of f on $[a, b]$	Other How to find critical points
Other How to find the absolute maxima and minima of f	Other How to find inflection points
Other How to find vertical asymptotes	Other How to find horizontal asymptotes
Other How to solve related rates problems	Other
Integration $\int dx$	Integration $\int a\,dx$

A critical point is any interior point where $f'(x) = 0$ or $f'(x)$ is undefined.	Find the slope of the secant line. $\frac{f(b) - f(a)}{b - a}$
Inflection points will exist where f'' changes signs.	Candidate's test: Compare function outputs at endpoints and points where f' changes sign. The y-value is the max/min!
Use end behavior. Find $\lim_{x \to -\infty} f(x)$ and $\lim_{x \to \infty} f(x)$	Set the denominator equal to 0 and solve for x.
	Write an equation that models the situation. Implicitly differentiate all variables that are changing with respect to time.
$ax + C$	$x + C$

Integration

$$\int x^n \, dx$$

Integration

$$\int x^{-1} \, dx \text{ OR } \int \frac{1}{x} \, dx \text{ OR } \int \frac{dx}{x}$$

Integration

$$\int \cos x \, dx$$

Integration

$$\int \sin x \, dx$$

Integration

$$\int \sec^2 x \, dx$$

Integration

$$\int \csc^2 x \, dx$$

Integration

$$\int \sec x \tan x \, dx$$

Integration

$$\int \csc x \cot x \, dx$$

Integration

$$\int e^x \, dx$$

Integration

$$\int a^x \, dx$$

$\ln\lvert x\rvert + C$	$\dfrac{x^{n+1}}{n+1} + C$
$-\cos x + C$	$\sin x + C$
$-\cot x + C$	$\tan x + C$
$-\csc x + C$	$\sec x + C$
$\dfrac{1}{\ln a} \cdot a^x + C$	$e^x + C$

Integration $$\int \frac{1}{\sqrt{1-x^2}}\,dx$$	Integration $$\int \frac{1}{1+x^2}\,dx$$
Integration Very rare! $$\int \frac{1}{\lvert x\rvert\sqrt{x^2-1}}\,dx$$	Integration $$\int_a^b \sqrt{r^2-x^2}\,dx$$
Interpretations and Justifications Intermediate Value Theorem (IVT)	Interpretations and Justifications Mean Value Theorem
Interpretations and Justifications A particle is speeding up if	Interpretations and Justifications A particle is slowing down if
Interpretations and Justifications Interpreting a derivative at $x = a$ in context	Interpretations and Justifications Interpreting an integral over $[a, b]$ in context

$\tan^{-1} x + C$

$\sin^{-1} x + C$

Use geometry!
This is a semicircle of radius r!

$\sec^{-1} x + C$

If $f(x)$ is continuous on $[a, b]$ and differentiable on (a, b) then

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

For some value c in (a, b).
Slope of the secant line = slope of the tangent line.
Average rate of change = instantaneous rate of change.

If $f(x)$ is continuous on $[a, b]$ then $f(x)$ takes on every value between $f(a)$ and $f(b)$.

$v(t)$ and $a(t)$
have opposite signs

$v(t)$ and $a(t)$
have the same sign

From $x =$ ___to x = ___the net change in ________ is ___ (units).

1. Interval
2. Context
3. Net change or accumulation
4. Units

At $x =$ ___, the _________is changing at a rate of ______ (units).

1. Instant
2. Context
3. Rate of change
4. Units

Interpretations and Justifications

f is increasing when

Interpretations and Justifications

f is decreasing when

Interpretations and Justifications

f is concave up when

Interpretations and Justifications

f is concave down when

Interpretations and Justifications

f has a relative max when

Interpretations and Justifications

f has a relative min when

Interpretations and Justifications

When a question asks you to "interpret the meaning"

Interpretations and Justifications

When a question asks you to "justify"

Interpretations and Justifications

Interpretations and Justifications

$f' < 0$	$f' > 0$
$f'' < 0$	$f'' > 0$
$f'(x) = 0$ or undefined and f' changes from – to + OR $f'(x) = 0$ and $f''(x) > 0$	$f'(x) = 0$ or undefined and f' changes from + to – OR $f'(x) = 0$ and $f''(x) < 0$
The response must include a definition or theorem. Be sure to verify the conditions of the theorem!	The response must include: 1. Meaning in context 2. Units 3. Time

Area / Volume Area by Riemann sums (rectangles)	Area / Volume Left Riemann sums are an overestimate if / underestimate if Right Riemann sums are an overestimate if / underestimate if
Area / Volume Area by trapezoids	Area / Volume Area using trapezoids will be an overestimate if… underestimate if…
Area / Volume Total area =	Area / Volume How to find the area between curves
Area / Volume Volume: Disks	Area / Volume Volume: Washers
Area / Volume Volume: Cross-sections	Area / Volume

Riemann Sum	Over estimate when f is	Under estimate when f is
Left	decreasing	increasing
Right	increasing	decreasing

$$\sum_{k=1}^{n} f(x_k) \cdot \Delta x$$

height width

The y-value/height could be at the left, right, or midpoint of each interval.

f is concave up

f is concave down

$$A = \frac{1}{2}\Delta x(y_0 + y_1) + \frac{1}{2}\Delta x(y_1 + y_2) + \ldots$$

$$\int_a^b (\text{higher} - \text{lower})\, dx = \int_a^b [f(x) - g(x)]\ dx$$

OR

$$\int_c^d (\text{right} - \text{left})\, dy = \int_c^d [f(y) - g(y)]\ dy$$

$$\int_a^b |f(x)|\, dx$$

$$\int_a^b \pi(R^2 - r^2)dx$$

OR

$$\int_c^d \pi(R^2 - r^2)dy$$

R = larger measurement from axis of revolution

$$\int_a^b \pi(\text{radius})^2 dx$$

OR

$$\int_c^d \pi(\text{radius})^2 dy$$

$$\int_a^b (\text{area of one cross section})\ dx$$

OR

$$\int_c^d (\text{area of one cross section})\ dy$$

Other $$\int_a^b f'(x)\,dx$$	Other Final amount / Final position $f(b) =$
Other Total distance traveled	Other Position Velocity Acceleration
Other Speed	Other If $F(x) = \int_a^{v(x)} f(t)dt$ then $F'(x) =$
Other Average value of a function f on $[a, b]$	Other Solving a differential equation
Other Solve $\frac{dy}{dx} = ky$	Other Displacement

$f(a) + \int_a^b f'(x)\,dx$ Starting amount + accumulation	$f(x)\Big]_a^b = f(b) - f(a)$ This gives the net change in the amount or position.
$f(t), x(t)$, or $y(t)$ $f'(t), x'(t)$, or $y'(t)$ $f''(t), x''(t)$, or $y''(t)$	$\int_a^b \lvert v(t)\rvert\,dt$
$f(v(x)) \cdot v'(x)$ Plug in the upper limit of integration. Multiply by the derivative of the upper limit.	$\lvert v(t)\rvert$
Separate Integrate Solve for C Isolate y Select the proper solution	$\frac{1}{b-a}\int_a^b f(x)\,dx$
$\int_{t_1}^{t_2} v(t)\,dt$	Exponential growth! $y = y_0 e^{kt}$