Stuff You Must Know Cold for AP Test – Name:______________________

Values of Trig Functions for Common Angles:

0°	$\sin\theta$	$\cos\theta$	$\tan\theta$
0			
$\pi/6$			
$\pi/4$			
$\pi/3$			
$\pi/2$			
π			

Careful with Trig Values: $\tan\left(\frac{3\pi}{4}\right) = -1$ but $\arctan(-1) = -\frac{\pi}{4}$

$\sin^2\theta + \cos^2\theta = 1$ $\quad 1+\tan^2\theta = \sec^2\theta$ $\quad 1+\cot^2\theta = \csc^2\theta$

$\sin^2\theta = \frac{1-\cos 2x}{2}$ $\quad \cos^2\theta = \frac{1+\cos 2x}{2}$

Limits

Limits to know:

$\lim\limits_{x\to 0}\frac{\sin x}{x} =$ $\quad \lim\limits_{x\to 0}\frac{1-\cos x}{x} =$ $\quad \lim\limits_{n\to\infty}\left(1+\frac{1}{n}\right)^n =$

Situations Limits Fail to Exist

1) ______________________
2) ______________________
3) ______________________

Definition of Continuity:

A function is continuous at the point $x = c$ if and only if:

1) ______________________
2) ______________________
3) ______________________

Intermediate Value Theorem

1) ______________________
2) ______________________
3) ______________________
4) Must be ______________________.

Derivatives

FORMAL Definition of Derivative

$\frac{d}{dx}\left(f(x)\right) =$ ______________________

Alternate Form of Definition of a Derivative

$\frac{d}{dx}\left(f(x)\right)$ at $x = c$ is ____________

Product Rule

$\frac{d}{dx}\left(f(x)g(x)\right) =$ ______________________

Quotient Rule

$\frac{d}{dx}\left(\frac{f(x)}{g(x)}\right) =$ ______________________

Chain Rule

$\frac{d}{dx}\left(f(g(x))\right) =$ ______________________

Situations Derivatives Fail to Exist

1) ______________________
2) ______________________
3) ______________________

Derivatives

Where u is a function of x and c is a constant

$\frac{d}{dx}(\sin u) =$ ________ $\quad \frac{d}{dx}(\csc u) =$ ________

$\frac{d}{dx}(\cos u) =$ ________ $\quad \frac{d}{dx}(\sec u) =$ ________

$\frac{d}{dx}(\tan u) =$ ________ $\quad \frac{d}{dx}(\cot u) =$ ________

$\frac{d}{dx}(e^u) =$ ________ $\quad \frac{d}{dx}(\ln u) =$ ________

$\frac{d}{dx}(a^u) =$ ________ $\quad \frac{d}{dx}(\log_a u) =$ ________

$\left(f^{-1}\right)'(a) =$ ______________________

$\frac{d}{dx}(\sin^{-1}u) =$ ______ $\quad \frac{d}{dx}(\csc^{-1}u) =$ ______

$\frac{d}{dx}(\cos^{-1}u) =$ ______ $\quad \frac{d}{dx}(\sec^{-1}u) =$ ______

$\frac{d}{dx}(\tan^{-1}u) =$ ______ $\quad \frac{d}{dx}(\cot^{-1}u) =$ ______

Curve Sketching and Analysis

Critical Values: $\frac{dy}{dx} =$ _____ *OR* ___________

Absolute/Global Max or Min: ___________ Test

Local/Relative MINIMUM

If $f' = 0$ changes from ______ to ________

OR $\frac{d^2y}{dx^2}$ ☐ 0

Local/Relative MAXIMUM

If $f' = 0$ changes from ______ to ________

OR $\frac{d^2y}{dx^2}$ ☐ 0

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Point of Inflection

1) If $f''(c) =$ ______ or $f''(c) =$ ______ does not exist **AND**

2) if $f''(x)$ changes from ________ to ________ or ________ to ________ at $x = c$ **OR** if $f'(x)$ changes from ________ to ________ or ________ to ________ at $x = c$

Extreme Value Theorem

If $f(x)$ is ____________ on $[a,b]$, then there exists both a ________________ and ________________.

The Mean Value Theorem (derivatives)

Slope of secant line = Slope of tangent line

___________ = _________________________

Must be _____________ and ________________

Particle Motion

Position = ________ Velocity = ______________

Speed = _________ Acceleration = ___________

Displacement = ____________________________

Total Distance travelled = __________________

Speed of object **increasing** when ____________ and ____________ have _________ signs

Speed of object **decreasing** when ____________ and ____________ have _________ signs

Integration

Where u is a function of x and c is a constant

$\int \cos u \, du =$ __________ $\int \sin u \, du =$ __________

$\int \sec^2 u \, du =$ __________ $\int \csc^2 u \, du =$ __________

$\int \sec u \tan u \, du =$ ______ $\int \csc u \cot u \, du =$ ______

$\int \tan u \, du =$ __________ $\int \cot u \, du =$ __________

$\int \sec u \, du =$ __________ $\int \csc u \, du =$ __________

$\int \frac{du}{u} =$ ______________ $\int e^u \, du =$ ____________

$\int a^u \, du =$ ____________ $\int \frac{du}{\sqrt{a^2 - u^2}} =$ _________

$\int \frac{du}{a^2 + u^2} =$ ___________ $\int \frac{du}{u\sqrt{u^2 - a^2}} =$ _________

Area Under the Curve (Trapezoids)

Riemann's Sum:

$\int_a^b f(x)dx =$ ____________________ or $A = bh$

$\lim_{n \to \infty} \sum_{k=1}^{n} a_k =$ _________________ **(Sigma equation)**

Trapezoidal Sum:

$\int_a^b f(x)dx =$ _________________ or $A = \frac{h(b_1 + b_2)}{2}$

1st Fundamental Theorem of Calculus

$\int_a^b f'(x) \, dx =$ _________________

Average Value of $f(x)$ on $[a,b]$:

____

2nd Fundamental Theorem of Calculus

$\frac{d}{dx} \int_a^x f(t)dt =$ _________________

2nd Fundamental Theorem (Chain Rule):

$\frac{d}{dx} \int_{g(x)}^{h(x)} f(t)dt =$ ______________________________

Euler's Method:

Given that $\frac{dy}{dx} = f(x, y)$ and solution passes through (x_0, y_0): __________________________

Logistic Differential Growth Equation:

$\frac{dP}{dt} =$ ______________________________

Logistic Differential Growth Equation:

$P =$ ______________

Solids of Revolution

Area between two curves: __________________

Disk: ____________ Washer: ________________

Volume by Cross Sections: _________________

Squares:	Isosceles Triangle:
Semicircles:	Equilateral Triangle:

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Arc Length (Perimeter)

$$s = \int_a^b \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_$$

Pythagorean Identities

$$\cos^2 x = \frac{1+\cos(2x)}{2}$$
$$\sin^2 x = \frac{1-\cos(2x)}{2}$$

L'Hôpital's Rule

If $\frac{f(a)}{g(b)} = \_\_\_$ *OR* $\_\_\_$,

then $\lim_{x \to a} \frac{f(x)}{g(x)} = \lim_{x \to a} \_\_\_\_\_$

Integration by Parts

$$\int u\,dv = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_$$

Integration of ln

$$\int \ln x \, dx = x \ln x - x + C$$

In Polar Curves

$x =$ __________ and $y =$ __________

Slope of Polar Curve

$$\frac{dy}{dx} = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_$$

Area within a Polar Curve

$$A = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_$$

Slope of a Parametric Equation

$$\frac{dy}{dx} = \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_$$

Velocity Vector $\langle \_\_, \_\_ \rangle$

Speed

$$\|v\| = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_$$

Total Distance

$$\int_{\text{inital time}}^{\text{final time}} |v(t)\,dt| = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_$$

Geometric Series: $\sum_{n=0}^{\infty} ar^n$

$$a + ar + ar^2 + ar^3 + \ldots + ar^{n-1} + \ldots = \sum_{n=0}^{\infty} ar^n$$

The series CONVERGES if: ________________

The series DIVERGES if: ________________

Sum: ________________________

*N*th Term Test: $\sum_{n=1}^{\infty} a_n$

It DIVERGES if: ________________

If the limit approaches 0, test is __________

(Test cannot be used to show convergence and converse is not true)

Ratio Test: $\sum_{n=0}^{\infty} ar^n$

It CONVERGES if: ________________

It DIVERGES if: ________________

If the limit equals to 1, test is __________

Root Test: $\sum_{n=1}^{\infty} a_n$

It CONVERGES if: ________________

It DIVERGES if: ________________

If the limit equals to 1, test is __________

Telescoping Test: $\sum_{n=1}^{\infty} (b_n - b_{n+1})$

It CONVERGES if it is expanded form and terms begin to "__________" out.
(Test cannot be used to show divergence. Infinite sum is the sum of the first few terms that do not subtract out.)

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p-Series Test: $\sum_{n=1}^{\infty} \frac{1}{n^P}$

The series CONVERGES if: ______________

The series DIVERGES if: _________________

If $p = 1$, then it is _____________________.

Integral Test: $\sum_{n=1}^{\infty} a_n$ where $a_n = f(n) \geq 0$

It CONVERGES if: _____________________

It DIVERGES if: ______________________

Remainder: $0 < R_n < \int_n^{\infty} f(x)\, dx$

Direct Comparison (a_n, b_n) **Test:** $\sum_{n=1}^{\infty} a_n$

It CONVERGES if $0 <$ ____ $\leq$ ____ and

____

It DIVERGES if $0 <$ ____ $\leq$ ____ and

____

(Note: $a_n > 0$ and $b_n > 0$)

Limit Comparison (a_n, b_n) **Test:** $\sum_{n=1}^{\infty} a_n$

It CONVERGES if $\lim_{n\to\infty} \frac{a_n}{b_n} = L$ where _______

It DIVERGES if $\lim_{n\to\infty} \frac{a_n}{b_n} = L$ where _______

(Note: $a_n > 0$ and $b_n > 0$ and L must be finite)

Alternating Series Test: $\sum_{n=1}^{\infty} (-1)^{n-1} a_n$

The series CONVERGES if: _____________ and

____

(This test cannot be used to test for divergence)

Alternating Series Remainder

If $S_n = \sum_{k=1}^{n} (-1)^n a_n$ is the nth partial sum of a convergent alternating series, _____________.

LaGrange's Error Bound:

If c equals a number centered on an x equals a value, approximate. There exists a z between x and c, such that:

$$|R_n| \leq \text{―――――――}(\qquad\qquad)$$

Find interval of $f^{n+1}(z)$ to find error interval.

Taylor Polynomial

If the function f has n derivatives at $x = c$, then the polynomial's equation for the nth term is:

$P_n(x) =$ ____________________________

Taylor Series

If function f is "smooth" at $x = c$, then f can be approximated by the nth degree polynomial

$f(x) =$ ____________________________

Maclaurin Series:

A Taylor Series about $x = 0$ is called Maclaurin.

$e^x =$ ____________________________

$\cos x =$ ____________________________

$\sin x =$ ____________________________

$\frac{1}{1-x} \approx$ ____________________________

$\ln(x+1) =$ ____________________________