Name: Date: Number:

Stuff You Must Know Cold – Algebra 1

Powers

$13^2 = 169$
$14^2 = 196$
$15^2 = 225$
$16^2 = 256$
$17^2 = 289$
$18^2 = 324$
$19^2 = 361$
$20^2 = 400$
$21^2 = 441$
$22^2 = 484$
$23^2 = 529$
$24^2 = 576$
$25^2 = 625$
$2^3 = 8$
$3^3 = 27$
$4^3 = 64$
$5^3 = 125$
$6^3 = 216$
$7^3 = 343$
$8^3 = 512$
$9^3 = 729$
$10^3 = 1000$
$11^3 = 1331$
$12^3 = 1728$
$2^4 = 16$
$3^4 = 81$
$4^4 = 256$
$5^4 = 625$
$6^4 = 1296$
$7^4 = 2401$
$8^4 = 4096$
$9^4 = 6561$
$10^4 = 10,000$

Powers

$2^5 = 32$
$3^5 = 243$
$4^5 = 1024$
$5^5 = 3125$
$2^6 = 64$
$2^7 = 128$
$2^8 = 256$
$2^9 = 512$
$2^{10} = 1024$
$2^{11} = 2048$
$2^{12} = 4096$

Factorials

$1! = 1$
$2! = 2$
$3! = 6$
$4! = 24$
$5! = 120$
$6! = 720$
$7! = 5040$

Linear Equations

Parent Function: $y = x$

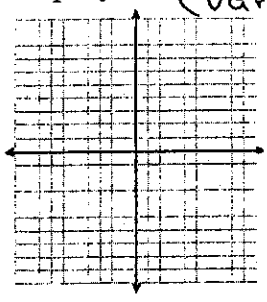
Standard Form: $ax + by = c$

Slope-Intercept Form: $y = mx + b$

Point-Slope Form: $y - y_1 = m(x - x_1)$

Slope: $\frac{y_2 - y_1}{x_2 - x_1} = \frac{\Delta y}{\Delta x} = \frac{\text{rise}}{\text{run}}$

Graph $y =$ (varies)



Quadratic Equations

Parent Function: $y = x^2$

Standard Form: $y = a(x-h)^2 + k$

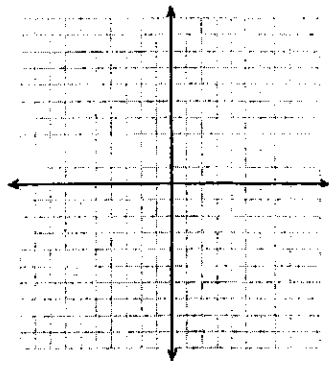
Intercept Form: $y = a(x-p)(x-q)$

Vertex: (h,k)

Axis of Symmetry: $x = \frac{-b}{2a}$

Quadratic Formula: $x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$

Graph $y =$ (varies)



Inequality Meanings

$<$ less than

$\leq$ less than or equal to

$>$ greater than

$\geq$ greater than or equal to

Three ways to solve a system of equations

1. Graphing
2. Substitution
3. Elimination

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Stuff You Must Know Cold – Algebra 1

Order of Operations

1. ( )
2. Exponents
3. Multiplication / Division L→R
4. Addition / Subtraction L-R

Absolute Value

$a \geq 0$

$|a| = a$

$|-a| = a$

Function Definitions

Domain: the set of all possible input values (usually x)

Range: the set of all possible output values (usually y)

Function: the relation for which each element of the domain corresponds to exactly one element of the range

Direct Variation: a relationship between two variables in which one is a constant multiple of the other $y = kx$

Indirect Variation: a relationship between two variables in which the product is a constant $y = \frac{k}{x}$

Roots: A number at which a polynomial has the value zero; where the graph crosses the x-axis

Properties (use a, b, c)

Commutative Addition: $a+b = b+c$

Multiplication: $a \cdot b = b \cdot c$

Associative Addition: $a + (b+c) = (a+b)+c$

Multiplication: $a \cdot (b \cdot c) = (a \cdot b) \cdot c$

Distributive: Addition $a \cdot (b+c) = ab + ac$

Measures of Central Tendency

Mean: arithmetic mean or average

Median: the middle number when a set of numbers are put in order

Mode: the number that occurs the most often in a list

Range: the difference between the largest and smallest numbers

Distance Formula

$d = \sqrt{(\Delta x)^2 + (\Delta y)^2}$

Midpoint Formula

$(m_1, m_2) = \left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$

Parallel and Perpendicular Lines

If $y = mx + b$

Parallel line slope: $m_1 = m_2$

Perpendicular line slope: $m_1 = \frac{-1}{m_2}$

Dimensional Analysis

($°C \Leftrightarrow °F, in \Leftrightarrow cm, ft \Leftrightarrow mi, etc.$)

Convert (varies)

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Stuff You Must Know Cold – Geometry

Area Formulas:

Square: s^2

Rectangle: $l \cdot w$

Parallelogram: $b \cdot h$

Trapezoid: $\frac{1}{2}(b_1 + b_2)h$

Circle: πr^2

Right Triangle: $\frac{1}{2}bh$

Any Triangle (Heron's Formula): $\sqrt{s(s-a)(s-b)(s-c)}$

Equilateral Triangle: $\frac{s^2\sqrt{3}}{4}$

Regular Polygon: $\frac{1}{2}ap$

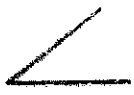
Surface Area Formulas:

Cube: $6s^2$

Sphere: $4\pi r^2$

Cylinder: $2\pi r^2 + 2\pi rh$

Angles:

 is an acute angle

 is an obtuse angle

Complementary angles add up to 90°

Supplementary angles add up to 180°

Volume Formulas:

Cube: s^3

Prism: $B \cdot h$

Cylinder: $\pi r^2 \cdot h$

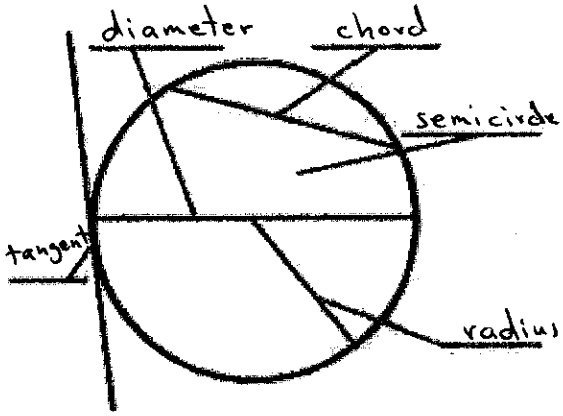
Pyramid: $\frac{1}{3}B \cdot h$

Cone: $\frac{1}{3}\pi r^2 \cdot h$

Sphere: $\frac{4}{3}\pi r^3$

Volume is measured in cubic units

Parts of a Circle:



Polygon Interior Angle Sums:

Triangle: 180°

Quadrilateral: 360°

Regular Polygon: $180°(n-2)$

Arc and Sector

Arc Length: $s = \theta \cdot r$ (θ: radians)

Sector Area: $\frac{1}{2}r^2\theta$

Roots to Know:

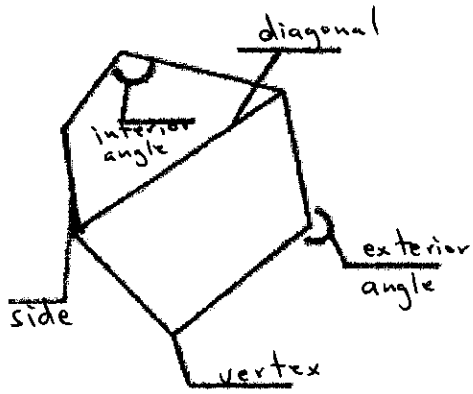
$\sqrt{2} \approx 1.4$

$\sqrt{3} \approx 1.7$

Polygon Names:

Sides:	Name:
3	triangle
4	quadrilateral
5	pentagon
6	hexagon
7	heptagon
8	octagon
9	nonagon
10	decagon

Polygon Parts:



Lines:

 is a line segment

 is a ray

 = parallel lines

Y = 2/3x + 4

Give a equation of a line Parallel: $y = \frac{2}{3}x + b$

Give a line Perpendicular: $y = -\frac{3}{2}x + b$

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Stuff You Must Know Cold – Geometry

Pythagorean Theorem:

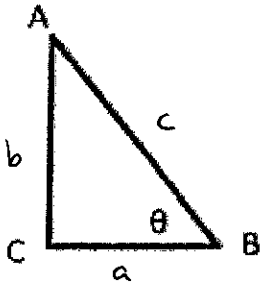
$a^2+b^2=c^2$

Trigonometry:

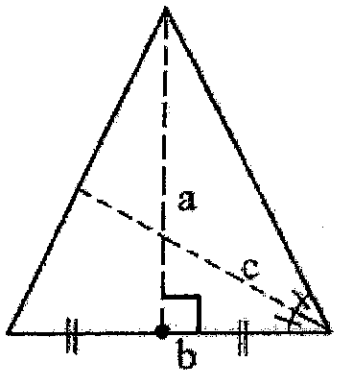
$\sin\theta = \frac{b}{c}$

$\cos\theta = \frac{a}{c}$

$\tan\theta = \frac{b}{a}$



Parts of a Triangle:



a: altitude or height

b: base

c: bisector

Similarity

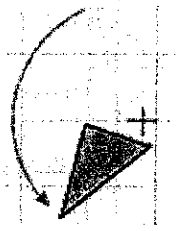
Ratio of sides	a:b
Ratio of perimeters	a:b
Ratio of areas	$a^2:b^2$
Ratio of volumes	$a^3:b^3$

Triangle Congruence:

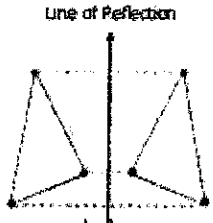
1. SSS
2. AAS
3. SAS
4. ASA
5. HL

Transformation

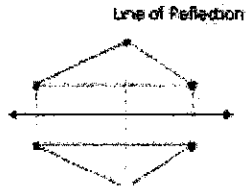
~~**Translations:**~~



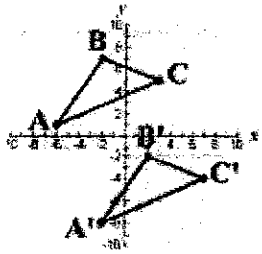
is a rotation



horizontal reflection



vertical reflection



is a translation

Logic

Conditional Statement: (varies) $P \rightarrow Q$

Converse: $Q \rightarrow P$

Inverse: $\sim P \rightarrow \sim Q$

Contrapositive: $\sim Q \rightarrow \sim P$

Perimeter Formulas:

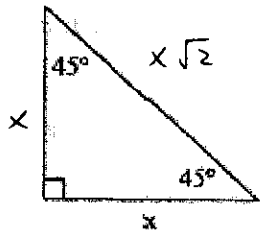
Square: $4s$

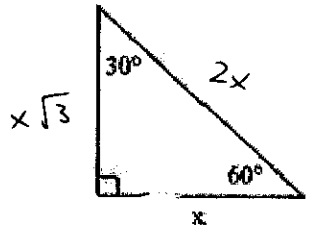
Rectangle: $2l + 2w$

Circumference of a Circle:

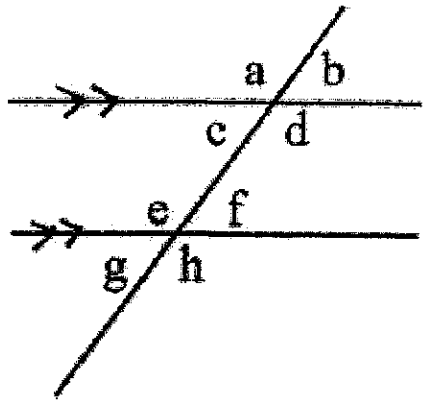
$2\pi r$

Special Right Triangles:





Parallel Lines:



a is congruent to: d, e, h

a is supplementary to:

c, b, f, g

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Stuff You Must Know Cold – Algebra II

Arithmetic Series

$t_n = t_1 + d(n-1)$

$S_n = \frac{n}{2}(2t_1 + d)$

$= \frac{n}{2}(t_1 + t_n)$

Geometric Series

$t_n = t_1 r^{n-1}$

$S_n = \frac{t_1(1 - r^n)}{1-r}$

$S = \frac{t_1}{1-r}$

Probability and Statistics

${}_nP_r = \frac{n!}{(n-r)!}$

${}_nC_r = \binom{n}{r} = \frac{n!}{(n-r)!\cdot(r!)}$

Basic Counting Principle with m,n, and l different items =

$m \cdot n \cdot l$

Transformations (a,b,h,k >0)

$y=f(x)-k$ down k units

$y=f(x-h)$ right k units

$y=-f(x)$ reflect over x-axis

$y=f(-x)$ reflect over y-axis

$y=f^{-1}(x)$ inverse reflect over $y=x$

$y=af(x)$ vertical expansion/compression

$y=f(bx)$ horizontal compression/expansion

Fractions

$\frac{0}{\#} = 0$

$\frac{0}{0}$ = indeterminant

$\frac{\#}{0}$ = undefined

Conjugate

of a + b is $a-b$

$(a-b)(a+b) = a^2 - b^2$

Horizontal Asymptote Rules:

$$y = \frac{ax^m + \ldots}{bx^n + \ldots}$$

1. $m > n$, no HA
2. $m < n$, $y = 0$
3. $m = n$, $y = \frac{a}{b}$

Vertical Asymptote Rules:

- simplify
- set denominator = 0
- roots are VA

Imaginary Numbers:

$\sqrt{-1} = i$

$i^2 = -1$

$i^3 = -i$

$i^4 = 1$

Arithmetic Operations

$ab + ac = a(b+c)$

$\frac{a}{b} + \frac{c}{d} = \frac{ad+bc}{bd}$

$\frac{a+b}{c} = \frac{a}{c} + \frac{b}{c}$

$\frac{\left(\frac{a}{b}\right)}{\left(\frac{c}{d}\right)} = \frac{ad}{bc}$

$\frac{\left(\frac{a}{b}\right)}{\frac{c}{1}} = \frac{a}{bc}$

$\frac{a}{\left(\frac{b}{c}\right)} = \frac{a \cdot c}{b}$

$\frac{a}{1}\left(\frac{b}{c}\right) = \frac{ab}{c}$

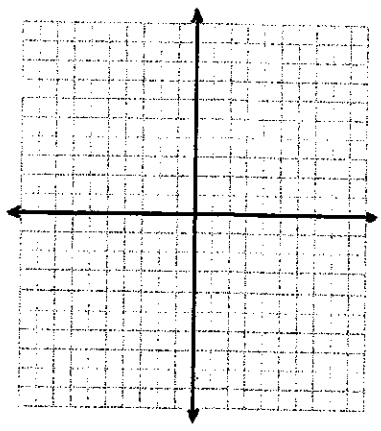
$\frac{a-b}{c-d} = \frac{b-a}{d-c}$

$\frac{ab+ac}{a} = b+c$

Parent Functions

Graph

$y =$ (varies)



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Stuff You Must Know Cold – Algebra II

Exponents and Radicals

$a^0 = 1 \quad , a \neq 0$

$(ab)^n = a^n b^n$

$a^x a^y = a^{x+y}$

$\sqrt{a} = a^{1/2}$

$\frac{a^x}{a^y} = a^{x-y}$

$\sqrt[n]{a} = a^{\frac{1}{n}}$

$\left(\frac{a}{b}\right)^x = \frac{a^x}{b^x}$

$\sqrt[n]{a^m} = a^{\frac{m}{n}}$

$a^{-x} = \frac{1}{a^x}$

$\sqrt[n]{ab} = \sqrt[n]{a} \cdot \sqrt[n]{b}$

$(a^x)^y = a^{(x \cdot y)}$

$\sqrt[n]{\frac{a}{b}} = \frac{\sqrt[n]{a}}{\sqrt[n]{b}}$

Interest/Half-Life

Compound Interest:

$A = P\left(1 + \frac{r}{n}\right)^{nt}$

Continuously Compounded:

$A = Pe^{rt}$

Half-Life:

$A_t = A_0\left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$

Logarithm Rules

Change from log to exponential

$\log_b y = x$

$y = b^x$

$\ln y = x$

$y = e^x$

$\log y = x$

$y = 10^x$

Change from exponential to log

$b^x = y$

$x = \log_b y$

More log rules

$\log_a a = 1$

$\log_a 1 = 0$

$\log_a a^n = n \cdot \log_a a = n$

$\log_b(mn) = \log_b m + \log_b n$

$\log_b\left(\frac{m}{n}\right) = \log_b m - \log_b n$

$\log_b m^n = n \log_b m$

Change of base formula

$\log_c a = \frac{\log a}{\log c}$

Intercepts

To find the x-intercept of any function:

set $y = 0$, solve for x

To find the y-intercept of any function:

set $x = 0$, solve for y

Conics (standard forms)

Circle:

$(x-h)^2 + (y-k)^2 = r^2$

Parabola

Vertical:

$(x-h)^2 = 4p(y-k)$

Horizontal:

$(y-k)^2 = 4p(x-h)$

Ellipse $a > b$

Vertical:

$\frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1$

Horizontal:

$\frac{(x-h)^2}{b^2} + \frac{(y-k)^2}{b^2} = 1$

Hyperbola

Vertical:

$-\frac{(x-h)^2}{b^2} + \frac{(y-k)^2}{a^2} = 1$

Horizontal:

$\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1$

Complete the Square: (varies)

Factoring

Difference of Squares

$a^2 - b^2 = (a-b)(a+b)$

Difference of Cubes

$a^3 - b^3 = (a-b)(a^2+ab+b^2)$

Sum of Cubes

$a^3 + b^3 = (a+b)(a^2-ab+b^2)$

Perfect Square Trinomial

$a^2 - 2ab + b^2 = (a-b)^2$

$a^2 + 2ab + b^2 = (a+b)^2$

Grouping

$ac + ad + bc + bd =$

$a(c+d) + b(c+d) = (a+b)(c+d)$

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Stuff You Must Know Cold – Pre-Cal

Even – Odd Functions

If $f(x)$ is even, then

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

If $f(x)$ is odd, then

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

Composite Functions

$f(x) =$ (varies)

$g(x) =$

$f(g(x)) =$

Triangles

Law of Cosines:

$c^2 = a^2 + b^2 - 2ab\cos C$

Law of Sines:

$\frac{\sin A}{a} = \frac{\sin B}{b}$

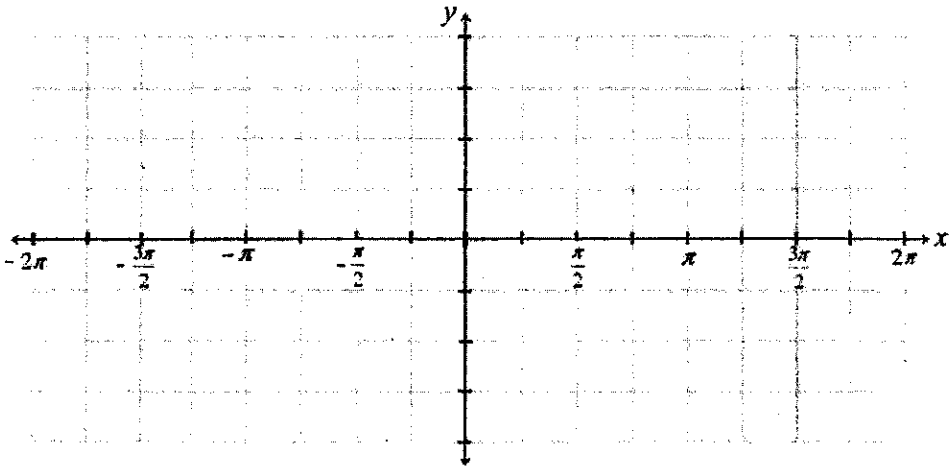
Values of Trigonometric Functions for Common Angles

θ	$\sin\theta$	$\cos\theta$	$\tan\theta$
0°	0	1	0
$\frac{\pi}{6}$	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3}$
$\frac{\pi}{4}$	$\frac{\sqrt{2}}{2} = \frac{1}{\sqrt{2}}$	$\frac{\sqrt{2}}{2}$	1
$\frac{\pi}{3}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$
$\frac{\pi}{2}$	1	0	und, ∞
π	0	-1	0

*Know both the **inverse trig** and the **trig** values. E.g.* $\tan^{-1}(1)$

Trig Graph

$y =$ (varies)

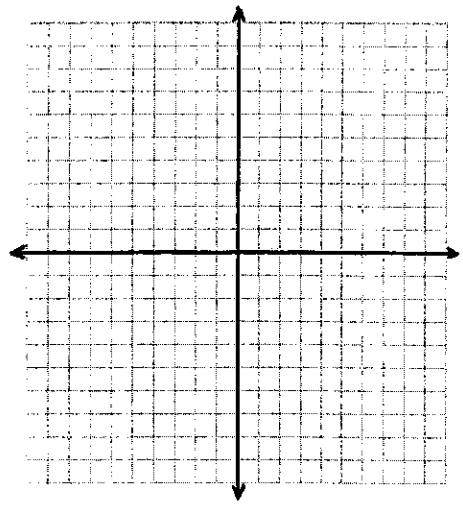


Parametric Equations

Graph

$x(t) =$ (varies)

$y(t) =$



Polar Equations

Standard Formulas

$x = r\cos\theta$

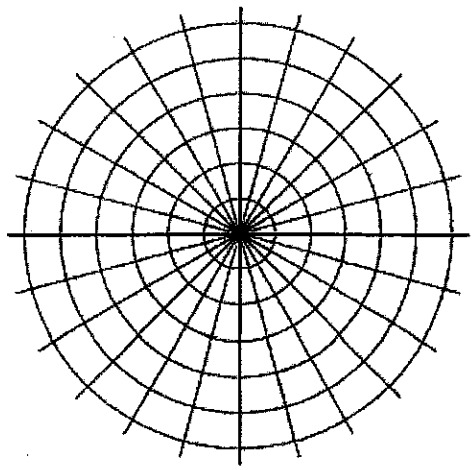
$y = r\sin\theta$

$\tan\theta = \frac{y}{x}$

$x^2 + y^2 = r^2$

Graph

$r =$ (varies)



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Stuff You Must Know Cold – Pre-Cal

Trig Identities

Double Angle

$\sin(2x) = 2\sin x \cos x$

$\cos(2x) = \cos^2 x - \sin^2 x$

$= 2\cos^2 x - 1$

$= 1 - 2\sin^2 x$

Power Reduction

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

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

Pythagorean

$\sin^2 x + \cos^2 x = 1$

$1 + \tan^2 x = \sec^2 x$

$\cot^2 x + 1 = \csc^2 x$

Reciprocal

$\sec x = \frac{1}{\cos x}$

$\cos x \sec x = 1$

$\csc x = \frac{1}{\sin x}$

$\sin x \csc x = 1$

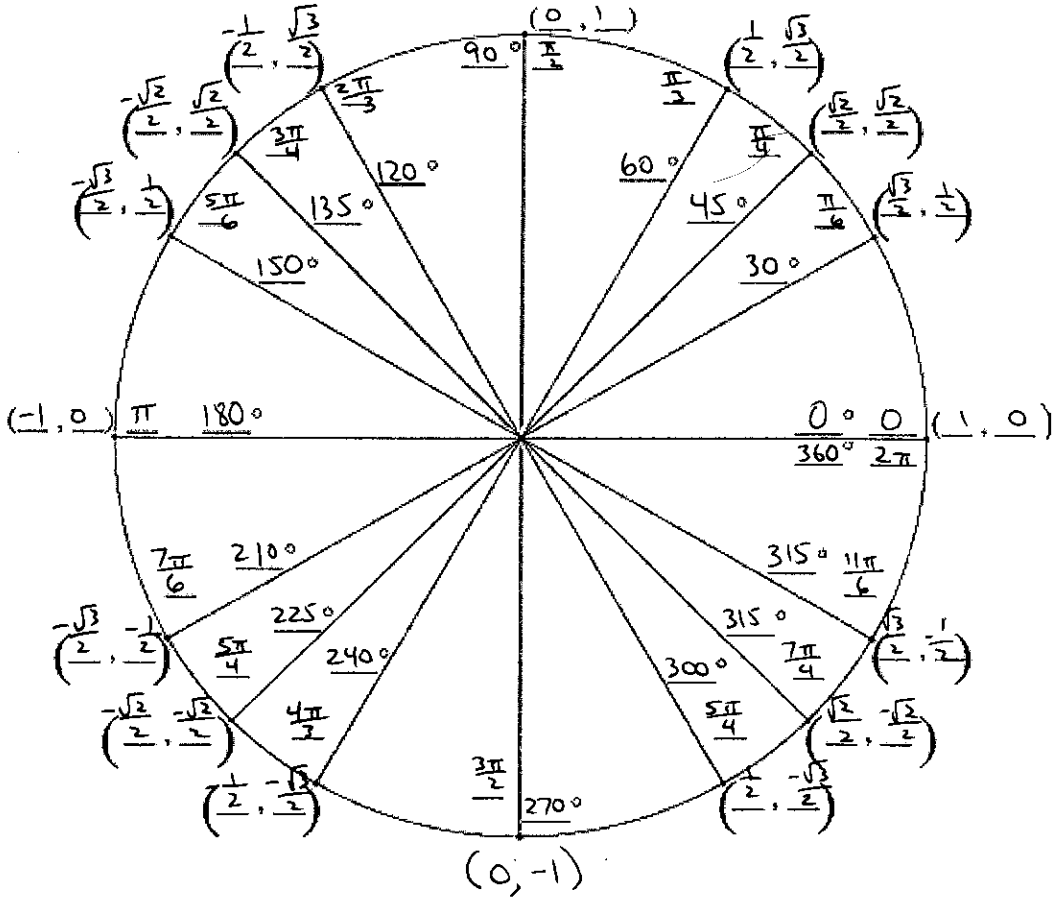
Even/Odd

$\sin(-x) = -\sin x$

$\cos(-x) = \cos x$

$\tan(-x) = -\tan x$

Trig Unit Circle



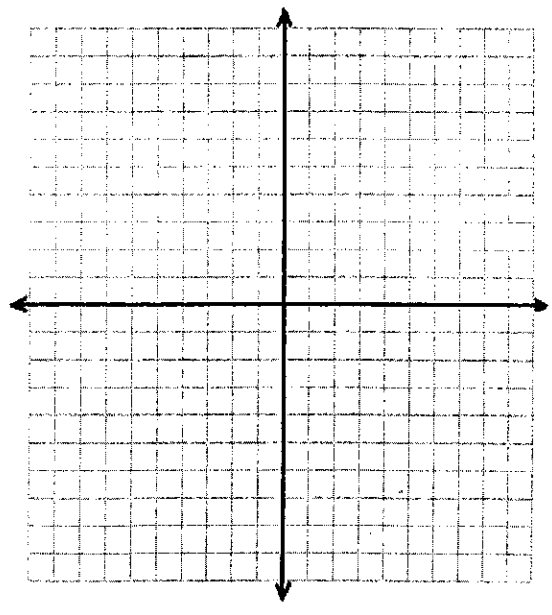
Vectors

(varies)

$\vec{u} = \langle \quad , \quad \rangle$

$\|\vec{u}\| =$

Graph $\vec{u}$



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Stuff You Must Know Cold – Cal AB/BC

Limits

Notation for:

Limit from the left of $f(x)$ as $x \to a$

$\lim_{x \to a^-} f(x)$

Limit from the right of $f(x)$ as $x \to a$

$\lim_{x \to a^+} f(x)$

Theorems:

$\lim_{x \to a} f(x) = F$ *and* $\lim_{x \to a} g(x) = G$

$\lim_{x \to a}(f(x)+g(x)) =$ $F+G$ $= \lim_{x \to a} f(x) + \lim_{x \to a} g(x)$

$\lim_{x \to a}(f(x)-g(x)) =$ $F-G$ $= \lim_{x \to a} f(x) - \lim_{x \to a} g(x)$

$\lim_{x \to a}(f(x)\cdot g(x)) =$ $F \cdot G$ $= \left[\lim_{x \to a} f(x)\right] \cdot \left[\lim_{x \to a} g(x)\right]$

$\lim_{x \to a}(f(x))^n =$ F^n $= \left[\lim_{x \to a} f(x)\right]^n$

$\lim_{x \to a} \frac{f(x)}{g(x)} =$ $\frac{F}{G}$ $= \left[\lim_{x \to a} f(x)\right] \div \left[\lim_{x \to a} g(x)\right]$

$\lim_{x \to 0} \frac{\sin x}{x} =$ 1

$\lim_{x \to 0} \frac{1-\cos x}{x} =$ 0

Definition of Continuity:

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

1. $f(a)$ is defined
2. $\lim_{x \to a^-} f(x) = \lim_{x \to a^+} f(x)$
3. $f(a) = \lim_{x \to a} f(x)$

Extreme Value Theorem

continuous on $[a,b]$

$a < c < b$, $a \le d \le b$

$f(d) \le f(x) \le f(c)$

Curve Sketching and Analysis

Critical Points: $f'(x) = 0$ or $\frac{\#}{0}$ look at endpoints

Global Min: check critical points $f''(x) > 0$

Global Max: check critical points $f''(x) < 0$

Point of Inflection: check concavity changes $f''(x) = 0$ or $\frac{\#}{0}$

Derivatives

Definition of Derivative

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

Alternate Form of Def. of Derivative

$\frac{d}{dx}(f(x))$ *at* $x = a$

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

Chain Rule

$\frac{d}{dx}[f(u)] = f'(u) \cdot u'$

Product Rule

$\frac{d}{dx}(uv) = uv' + vu'$

Quotient Rule

$\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{vu' - uv'}{v^2}$

Where u and v are functions of x

More Derivatives

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

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

$\frac{d}{dx}(\sin u) = \cos u\,(u')$

$\frac{d}{dx}(\cos u) = -\sin u\,(u')$

$\frac{d}{dx}(\tan u) = \sec^2 u\,(u')$

$\frac{d}{dx}(\cot u) = -\csc^2 u\,(u')$

$\frac{d}{dx}(\sec u) = (\sec u)(\tan u)\,u'$

$\frac{d}{dx}(\csc u) = -(\csc u)(\cot u)\,u'$

$\frac{d}{dx}(\ln u) = \frac{u'}{u}$

$\frac{d}{dx}(e^u) = e^u \cdot u'$

$\frac{d}{dx}(\sin^{-1} u) = \frac{u'}{\sqrt{1-u^2}}$

$\frac{d}{dx}(\cos^{-1} u) = \frac{-u'}{\sqrt{1-u^2}}$

$\frac{d}{dx}(\tan^{-1} u) = \frac{u'}{1+u^2}$

$\frac{d}{dx}(\cot^{-1} u) = \frac{-u'}{1+u^2}$

$\frac{d}{dx}(a^u) = a^u \cdot \ln a \cdot u'$

$\frac{d}{dx}(\log_a u) = \frac{d}{dx}\left(\frac{\ln u}{\ln a}\right) = \frac{1}{\ln a} \cdot \frac{u'}{u}$

Intermediate Value Theorem

continuous $[a,b]$ there is atleast one number $x = c$ in the open interval (a,b) such that $f(c) = y$

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The Mean Value Theorem
(derivatives) continuous $[a,b]$

also: $f'(c) = \dfrac{f(b)-f(a)}{b-a}$

Rolle's Theorem continuous $[a,b]$

if $f(a)=f(b)$, then there is at least one number $x=c$ in (a,b) such that $f'(c)=0$

The Fundamental Theorem of Calculus

$\int_a^b f(x)\,dx = F(b)-F(a)$

where $F'(x) = f(x)$

Corollary to FTC

$\dfrac{d}{dx}\int_a^{g(x)} f(t)dt =$

$f(g(x))\cdot g'(x)$

Trapezoidal Rule

add up the trapezoidal area in each subinterval

Mean Value Theorem for Integrals
(Average Value) continuous $[a,b]$

$x=c$ on (a,b)

$f(c) = \dfrac{\int_a^b f(x)dx}{b-a}$

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

$V = \int_a^b Area(x)\,dx$

Arc Length (rectangular)

$L = \int_a^b \sqrt{1+[f'(x)]^2}\,dx$

Distance, Velocity, and Acceleration
$s(t)$ is the position function,
$\langle x(t), y(t)\rangle$ is the position in parametric

velocity = $s'(t)$

acceleration = $v'(t) = s''(t)$

velocity vector = $\langle x'(t), y'(t)\rangle$

acceleration vector = $\langle x''(t), y''(t)\rangle$

speed (rectangular and parametric) =

$|v| = \sqrt{(x'(t))^2+(y'(t))^2}$

displacement = $\int_a^b v\,dt$

distance (rectangular and parametric) =

$\int_a^b |v|\,dt$

$\int_a^b \sqrt{(x')^2+(y')^2}\,dt$

average velocity =

$\dfrac{\Delta s}{\Delta t}$

l'Hôpital's Rule (Bernoulli's Rule)

If $\dfrac{f(a)}{g(a)} = \dfrac{0}{0}$ or $\dfrac{\infty}{\infty}$

then $\lim\limits_{x\to a}\dfrac{f(x)}{g(x)} = \lim\limits_{x\to a}\dfrac{f'(x)}{g'(x)}$

Euler's Method

$x_{new} = x_{old} + \Delta x$

$y_{new} = y_{old} + \left.\dfrac{dy}{dx}\right|_{(x_{old},y_{old})}\cdot\Delta x$

Integration by Parts

$\int u\,dv = uv - \int v\,du$

Logistics

$\dfrac{dP}{dt} = kP(c-P)$

Parametric Equations

$\dfrac{dy}{dx} = \dfrac{\frac{dy}{dt}}{\frac{dx}{dt}}$

$\dfrac{d^2y}{dx^2} = \dfrac{\frac{d}{dt}\left(\frac{dy}{dx}\right)}{\frac{dx}{dt}}$

Polar Curves

Area = $\int_a^b \frac{1}{2}r^2\,d\theta$

Slope = $\dfrac{\frac{dy}{d\theta}}{\frac{dx}{d\theta}}$

Taylor Series centered at $x=a$

$f(x) \approx f(a) + f'(a)(x-a) + \dfrac{f''(a)}{2!}(x-a)^2 + \dots + \dfrac{f^{(n)}(a)}{n!}(x-a)^n$

Maclaurin Series
about $x=0$

$e^x = 1 + x + \dfrac{x^2}{2!} + \dfrac{x^3}{3!} + \dots$

$\cos x = 1 - \dfrac{x^2}{2!} + \dfrac{x^4}{4!} - \dots$

$\sin x = x - \dfrac{x^3}{3!} + \dfrac{x^5}{5!} - \dots$

$\dfrac{1}{1-x} = 1 + x + x^2 + x^3 + \dots$

$\ln(x+1) = x - \dfrac{x^2}{2} + \dfrac{x^3}{3} - \dfrac{x^4}{4} + \dots$

Series Tests/Error Bound
(varies)