

## Greek Characters

Name	Symbol	Typical use(s)
alpha	$\alpha$	angle, constant
beta	$\beta$	angle, constant
gamma	$\gamma$	angle, constant
delta	$\delta$	limit definition
epsilon	$\epsilon$ or $\varepsilon$	limit definition
theta	$\theta$ or $\vartheta$	angle
lambda	$\lambda$	Lagrange multiplier
pi	$\pi$ or $\pi$	circular constant
phi	$\phi$ or $\varphi$	angle

## Named Sets

empty set	$\emptyset$
real numbers	$\mathbf{R}$
ordered pairs	$\mathbf{R}^2$
ordered triples	$\mathbf{R}^3$
integers	$\mathbf{Z}$
positive integers	$\mathbf{Z}_{>0}$
positive real numbers	$\mathbf{R}_{>0}$

## Set Symbols

Meaning	Symbol
is a member	$\in$
subset	$\subset$
intersection	$\cap$
union	$\cup$
set minus	$\setminus$

## Intervals

For numbers  $a$  and  $b$ , we define the intervals:

$$(a, b) = \{x \in \mathbf{R} \mid a < x < b\}$$

$$[a, b) = \{x \in \mathbf{R} \mid a \leq x < b\}$$

$$(a, b] = \{x \in \mathbf{R} \mid a < x \leq b\}$$

$$[a, b] = \{x \in \mathbf{R} \mid a \leq x \leq b\}$$

## Logic Symbols

Meaning	Symbol
negation	$\neg$
and	$\wedge$
or	$\vee$
implies	$\Rightarrow$
equivalent	$\equiv$
for all	$\forall$
there exists	$\exists$

## Exponents

For  $a, b > 0$  and  $m, n$  real:

$$a^n a^m = a^{n+m}$$

$$a^n / a^m = a^{n-m}$$

$$(a^n)^m = a^{n \cdot m}$$

$$a^{-m} = 1/a^m$$

$$(a/b)^m = a^m/b^m$$

## Trigonometric Functions

### Special values of trig functions

$x$	$\cos(x)$	$\sin(x)$	$\tan(x)$
0	1	0	0
$\pi/6$	$\sqrt{3}/2$	$1/2$	$1/\sqrt{3}$
$\pi/4$	$1/\sqrt{2}$	$1/\sqrt{2}$	1
$\pi/3$	$1/2$	$\sqrt{3}/2$	$\sqrt{3}$
$\pi/2$	0	1	dne
$2\pi/3$	$-1/2$	$\sqrt{3}/2$	$-\sqrt{3}$
$3\pi/4$	$-1/\sqrt{2}$	$1/\sqrt{2}$	-1
$5\pi/6$	$-\sqrt{3}/2$	$1/2$	$-1/\sqrt{3}$
$\pi$	-1	0	0
$7\pi/6$	$-\sqrt{3}/2$	$-1/2$	$-1/\sqrt{3}$
$5\pi/4$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	1
$4\pi/3$	$-1/2$	$-\sqrt{3}/2$	$-\sqrt{3}$
$3\pi/2$	0	-1	dne
$5\pi/3$	$1/2$	$-\sqrt{3}/2$	$-\sqrt{3}$
$7\pi/4$	$1/\sqrt{2}$	$-1/\sqrt{2}$	-1
$11\pi/6$	$\sqrt{3}/2$	$-1/2$	$-1/\sqrt{3}$

### Special values of inverse trig

$x$	$\arccos(x)$	$\arcsin(x)$
-1	$\pi$	$-\pi/2$
$-\sqrt{3}/2$	$5\pi/6$	$-\pi/3$
-1/2	$2\pi/3$	$-\pi/6$
0	$\pi/2$	0
1/2	$\pi/3$	$\pi/6$
$\sqrt{3}/2$	$\pi/6$	$\pi/3$
1	0	$\pi/2$

### Special values arctan and arccotan

$x$	$\arctan(x)$	$\operatorname{arccot}(x)$
$-\sqrt{3}$	$-\pi/3$	$-\pi/6$
-1	$-\pi/4$	$-\pi/4$
$-1/\sqrt{3}$	$-\pi/6$	$-\pi/3$
0	0	$\pi/2$
$1/\sqrt{3}$	$\pi/6$	$\pi/3$
1	$\pi/4$	$-\pi/4$
$\sqrt{3}$	$\pi/3$	$\pi/6$

## Trigonometric identities

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

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

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

$$\sin(x + y) = \sin(x) \cos(y) + \cos(x) \sin(y)$$

$$\cos(x + y) = \cos(x) \cos(y) - \sin(x) \sin(y)$$

## Limits

$$\lim_{x \rightarrow 0} \frac{\sin(x)}{x} = 1$$

$$\lim_{x \rightarrow 0} \frac{1 - \cos(x)}{x} = 0$$

$$\lim_{x \rightarrow \infty} e^x = \infty$$

$$\lim_{x \rightarrow -\infty} e^x = 0$$

$$\lim_{x \rightarrow \infty} \ln(x) = \infty$$

$$\lim_{x \rightarrow 0^+} \ln(x) = -\infty$$

$$\lim_{x \rightarrow 0} (1 + x)^{1/x} = e$$

## Derivatives

### General Cases

$F(x)$	$F'(x)$
$af(x) + bg(x)$	$af'(x) + bg'(x)$
$f(x)g(x)$	$f'(x)g(x) + f(x)g'(x)$
$1/g(x)$	$-g'(x)/g(x)^2$
$f(x)/g(x)$	$(g(x)f'(x) - f(x)g'(x))/g(x)^2$
$f(g(x))$	$g'(x)f'(g(x))$
$f^{-1}(x)$	$1/f'(f^{-1}(x))$

### Specific cases

$F(x)$	$F'(x)$
$\cos(x)$	$-\sin(x)$
$\sin(x)$	$\cos(x)$
$\tan(x)$	$\sec(x)^2$
$\sec(x)$	$\sec(x) \tan(x)$
$\csc(x)$	$-\cot(x) \csc(x)$
$\cot(x)$	$-\csc(x)^2$
$\arccos(x)$	$-1/\sqrt{1-x^2}$
$\arcsin(x)$	$1/\sqrt{1-x^2}$
$\arctan(x)$	$1/(x^2+1)$
$\operatorname{arcsec}(x)$	$1/(\sqrt{x^2-1} x )$
$\operatorname{arccsc}(x)$	$-1/(\sqrt{x^2-1} x )$
$\operatorname{arccot}(x)$	$-1/(x^2+1)$
$\exp(x)$	$\exp(x)$
$\ln(x)$	$1/x$
$\log_a(x)$	$1/x \ln(a), a \in \mathbf{R}_{>0}$
$x^a$	$ax^{a-1}$

## Antiderivatives<sup>1</sup>

$$\int a dx = ax$$

$$\int x^a dx = \frac{1}{1+a} x^{a+1}, \quad \text{if } a \neq -1$$

$$\int \frac{1}{x} dx = \ln|x|$$

$$\int \cos(x) dx = \sin(x)$$

$$\int \sin(x) dx = -\cos(x)$$

$$\int \tan(x) dx = \ln|\sec(x)|$$

$$\int \sec(x) dx = \ln|\tan(x) + \sec(x)|$$

$$\int \csc(x) dx = -\ln|\csc(x) + \cot(x)|$$

$$\int \cot(x) dx = \ln|\sin(x)|$$

$$\int 2|x| dx = x|x|$$

$$\int 2[x] dx = (2x-1)[x] - [x]^2$$

$$\int 2[x] dx = (2x+1)[x] - [x]^2$$

## Sums

For  $k, m, n \in \mathbb{Z}_{>0}$  and  $\alpha, \beta \in \mathbb{R}$

$$\sum_{k=0}^{n-1} 1 = n$$

$$\sum_{k=0}^{n-1} k = \frac{(n-1)n}{2}$$

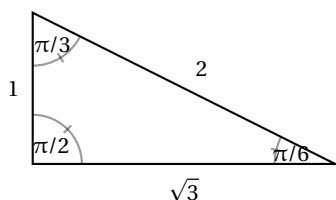
$$\sum_{k=0}^{n-1} k^2 = \frac{(n-1)n(2n-1)}{6}$$

$$\sum_{k=m}^n a_k = \sum_{k=0}^{n-m} a_{k+m}$$

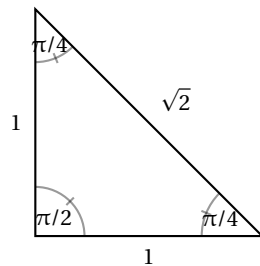
$$\sum_{k=m}^n \alpha a_k + \beta b_k = \alpha \sum_{k=m}^n a_k + \beta \sum_{k=m}^n b_k$$

## Famous Triangles

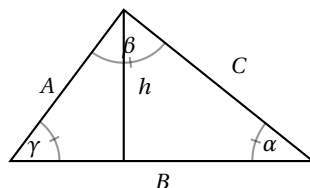
### The 30-60-90 triangle



### The 45-45-90 triangle



## Laws of Cosine & Sine



### Law of cosine

$$C^2 = A^2 + B^2 - 2AB \cos(\gamma)$$

### Law of sines

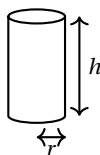
$$\frac{\sin \alpha}{A} = \frac{\sin \beta}{B} = \frac{\sin \gamma}{C}$$

### Areas and volumes

$$\text{Area} = \frac{1}{2} hB = \frac{1}{2} AB \sin(\gamma)$$

## Volumes

### Right Circular Cylinder



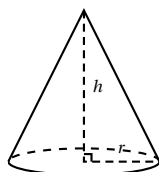
Volume

$$V = \pi r^2 h$$

Area, not including areas of circular ends

$$A = 2\pi r h$$

### Cone



Volume

$$V = \frac{1}{3} \pi r^2 h$$

Area, not including area of circular base:

$$A = \pi r \left( r + \sqrt{r^2 + h^2} \right)$$

## Applications

Arclength of curve  $y = F(x)$  with  $a \leq x \leq b$

$$= \int_a^b \sqrt{1 + F'(x)^2} dx$$

For the region  $Q$  of the  $xy$  plane given by

$$Q = \{(x, y) \mid f(x) \leq y \leq g(x) \wedge a \leq x \leq b\},$$

we have

$$\text{Area}(Q) = \int_a^b g(x) - f(x) dx$$

Assuming  $0 \leq f(x)$  and rotating about the  $x$ -axis

$$\text{Vol}(Q) = \pi \int_a^b g(x)^2 - f(x)^2 dx$$

Assuming  $a \geq 0$  and rotating about the  $y$ -axis

$$\text{Vol}(Q) = 2\pi \int_a^b x(g(x) - f(x)) dx$$

Centroid

$$\text{Area}(Q) \times \bar{x} = \int_a^b x(g(x) - f(x)) dx,$$

$$\text{Area}(Q) \times \bar{y} = \frac{1}{2} \int_a^b (g(x)^2 - f(x)^2) dx.$$

For the region described by

$$Q = \{(x, y) \mid f(y) \leq x \leq g(y) \wedge a \leq y \leq b\},$$

interchange  $x$  and  $y$  in all the previous formulas. Specifically we have

$$\text{Area}(Q) = \int_a^b g(y) - f(y) dy$$

Assuming  $0 \leq f(y)$  and rotating about the  $y$ -axis

$$\text{Vol}(Q) = \pi \int_a^b g(y)^2 - f(y)^2 dy$$

Assuming  $a \geq 0$  and rotating about the  $x$ -axis

$$\text{Vol}(Q) = 2\pi \int_a^b y(g(y) - f(y)) dy$$

Centroid

$$\text{Area}(Q) \times \bar{y} = \int_a^b y(g(y) - f(y)) dy$$

$$\text{Area}(Q) \times \bar{x} = \frac{1}{2} \int_a^b (g(y)^2 - f(y)^2) dy$$

<sup>1</sup>Valid on any interval on which the antiderivative is continuous.