

## 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
pi	$\pi$ or $\pi$	circular constant
phi	$\phi$ or $\varphi$	angle, constant

## Named sets

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

## Set symbols

Meaning	Symbol	Meaning	Symbol
is a member	$\in$	union	$\cup$
subset	$\subset$	complement	superscript <sup>C</sup>
intersection	$\cap$	set minus	$\setminus$

## Logic symbols

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

## Arithmetic properties of $\mathbf{R}$

$(\forall a, b \in \mathbf{R})(a + b = b + a)$	commutivity
$(\forall a, b, c \in \mathbf{R})(a + (b + c) = (a + b) + c)$	associative
$(\forall a, b \in \mathbf{R})(ab = ba)$	commutivity
$(\forall a, b, c \in \mathbf{R})(a(bc) = (ab)c)$	associative
$(\forall a, b, c \in \mathbf{R})(a(b + c) = ab + ac)$	distributive

## Distance & Midpoint

The distance between the points  $(x_1, y_1)$  and  $(x_2, y_2)$  is

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}.$$

The midpoint is the point

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

## Exponents

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

$$\begin{aligned} a^0 &= 1, & 0^a &= 0 \\ 1^a &= 1, & a^n a^m &= a^{n+m} \\ a^n / a^m &= a^{n-m}, & (a^n)^m &= a^{n \cdot m} \\ a^{-m} &= 1/a^m, & (a/b)^m &= a^m / b^m \end{aligned}$$

## Radicals

$$\begin{aligned} \sqrt[n]{a} &= a^{1/n} \\ \sqrt[n]{ab} &= \sqrt[n]{a} \sqrt[n]{b} \quad (\text{provided } a, b \geq 0) \\ \sqrt[m]{\sqrt[n]{a}} &= \sqrt[mn]{a} \\ \sqrt[n]{\frac{a}{b}} &= \frac{\sqrt[n]{a}}{\sqrt[n]{b}} \\ \sqrt[n]{a^n} &= \begin{cases} a & n \text{ odd} \\ |a| & n \text{ even} \end{cases} \end{aligned}$$

## Identities

$$\begin{aligned} a(b + c) &= ab + ac \\ ((a + b)(c + d)) &= ac + ad + bc + bd \\ \frac{ab + ac}{a} &= b + c \quad (\text{provided } a \neq 0) \\ \frac{\frac{a}{b}}{\frac{c}{d}} &= \frac{ad}{bc} \quad (\text{provided } b, d \neq 0) \\ \sqrt{ab} &= \sqrt{a}\sqrt{b} \quad (\text{provided } a \geq 0, b \geq 0) \\ \ln(ab) &= \ln(a) + \ln(b) \quad (\text{provided } a \geq 0, b \geq 0) \end{aligned}$$

## Solution of Equations

### Algebraic

$$\begin{aligned} [ab = 0] &\equiv [a = 0 \text{ or } b = 0] \\ [a^2 = b^2] &\equiv [a = b \text{ or } a = -b] \\ \left[\frac{a}{b} = 0\right] &\equiv [a = 0 \text{ and } b \neq 0] \\ \left[\frac{a}{b} = \frac{c}{d}\right] &\equiv [ad = bc \text{ and } b \neq 0 \text{ and } d \neq 0] \\ [|a| = |b|] &\equiv [a = b \text{ or } a = -b] \\ [\sqrt{a} = b] &\equiv [a = b^2 \text{ and } b \geq 0] \end{aligned}$$

For  $a \neq 0$ ,

$$[ax^2 + bx + c = 0] \equiv \left[ x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \right]$$

### Exponential

$$\begin{aligned} [\ln(a) = 0] &\equiv [a = 1] \\ [e^a = 1] &\equiv [a = 0] \\ [\ln(a) = b] &\equiv [a = e^b] \end{aligned}$$

## Parabolas & Lines

The vertex of the parabola  $ax^2 + bx + c = y$  is

$$\left( x = -\frac{b}{2a}, y = c - \frac{b^2}{4a} \right).$$

An equation of the line that contains the points  $(x = x_1, y = y_1), (x = x_2, y = y_2)$  is

$$y - y_1 = \left( \frac{y_2 - y_1}{x_2 - x_1} \right) (x - x_1).$$

The number  $\frac{y_2 - y_1}{x_2 - x_1}$  is the slope.

## Function notation

$\text{dom}(F)$	domain of function $F$
$\text{range}(F)$	range of function $F$

## Domains, Ranges, and Zeros

Function	Domain	Range	Zeros
ln, log	$(0, \infty)$	$(-\infty, \infty)$	1
exp	$(-\infty, \infty)$	$(0, \infty)$	$\emptyset$
abs	$(-\infty, \infty)$	$(0, \infty)$	0
$\sqrt{\quad}$	$(0, \infty)$	$(0, \infty)$	0
$\sqrt[3]{\quad}$	$(-\infty, \infty)$	$(-\infty, \infty)$	0
floor	$(-\infty, \infty)$	$\mathbf{Z}$	$[0, 1)$
ceiling	$(-\infty, \infty)$	$\mathbf{Z}$	$(-1, 0]$

## Logarithms

$$\log_a(x) = \frac{\ln(x)}{\ln(a)}$$

## Compound Interest

Interest rate  $r$  compounded  $n$  times per year

$$A = P(1 + r/n)^{nt}$$

Continuous compounding:

$$A = Pe^{rt}$$

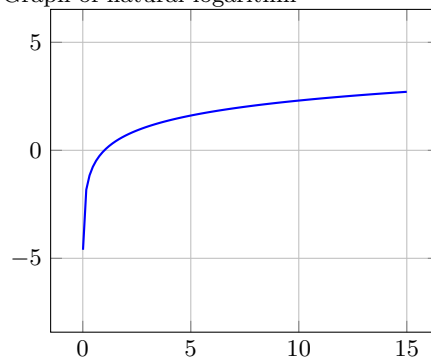
## Graph Translations

For the graph of  $F(x, y) = 0$

- The graph of  $F(x - h, y) = 0$  is the graph of  $F(x, y) = 0$  translated  $h$  units to the right.
- The graph of  $F(x, y - k) = 0$  is the graph of  $F(x, y) = 0$  translated  $k$  units up.
- The graph of  $F(x/c, y) = 0$  is the graph of  $F(x, y) = 0$  stretched a factor of  $c$  horizontally.
- The graph of  $F(x, y/c) = 0$  is the graph of  $F(x, y) = 0$  stretched a factor of  $c$  vertically.

## Graphs

Graph of natural logarithm



Graph of natural exponential

