

## Useful Mathematical Symbols

Symbol	What it is	How it is read	How it is used	Sample expression
+	Addition sign Logical OR symbol	... plus ... ... or ...	Sum of a few values Logical disjunction	$2 + 6 = 8$ $\neg(A + B) = \neg A * \neg B$
*	Multiplication sign Logical AND symbol	... times ... ... and ...	Product of two values Logical conjunction	$2 \times 6 = 12$ $\neg(A * B) = \neg A + \neg B$
x	Multiplication sign	... times ...	Product of two values	$4 \times 2 = 8$
·	Multiplication sign	... times ...	Product of two values	$4 \cdot 2 = 8$
$\Sigma$	summation sign	The summation of ...	Sum of many or infinitely many values	$\sum_{n=1}^{\infty} \frac{1}{n}$
$\int$	Integral sign	The integral of ...	integration	$\int x^2 dx = x^3/3 + c$
$\iint$	double integral sign	The double integral of ...	integration	$\iint f(x,y) dx dy$
$\iiint$	Triple integral sign	The triple integral of ...	integration	$\iiint f(x,y,z) dx dy dz$
$\oint$	Line integral sign	The line integral of ...	integration	$\oint \mathbf{F} \cdot d\mathbf{x}$
$\iint_S$	Surface integral sign	The surface integral of ...	integration	$\iint_S f(x,y,z) dx dy$
-	Subtraction sign Minus sign	... minus ... Negative...	Difference of two values, negative number	$2 - 6 = -4$
$\pm$	Plus/minus sign	... plus or minus ...	Expression of range, error, or tolerance	$540 \text{ kbps} \pm 10\%$
•	Dot product sign	... dot ...	Scalar (dot) product of two vectors	$\mathbf{A} \cdot \mathbf{B} = \mathbf{B} \cdot \mathbf{A}$
$\times$	Cross product sign	... cross ...	Vector (cross) product of two vectors	$\mathbf{A} \times \mathbf{B} = -(\mathbf{B} \times \mathbf{A})$
$\prod$	Product sign	The product of ...	Product of three up to infinitely many values	$\prod_{n=1}^{\infty} \frac{1}{n}$
^	Carat	... to the power of ...	exponent	$2^4 = 16$

!	Exclamation	... factorial	Product of all positive integers up to a certain value	$3! = 6$
$\sqrt[n]{\phantom{x}}$	surd	... root of ...	Algebraic expressions	$z = \sqrt[n]{(x+y)}$
$\sqrt{\phantom{x}}$	square root symbol	The square root of ...	Algebraic expressions	$\sqrt{4} = \pm 2$
...	Continuation sign	... and so on up to ... ... and so on indefinitely	Extension of sequence	$S = \{1, 2, 3, \dots\}$
/	Slash	... divided by ... ... over ...	Division	$3/4 = 0.75$
$\div$	Division sign	... divided by ...	Division	$3 \div 4 = 0.75$
%	Percent symbol	... percent ...	Proportion	$0.032 = 3.2\%$
$\text{‰}$	Per mil symbol	... per mil ...	Proportion	$0.032 = 32\text{‰}$
:	Colon, ratio sign	... is to ... ... such that ... ... it is true that ...	Division or ratio, symbol following logical quantifier or used in defining a set	$2:4 = 20:40$ $\exists x : x > 4 \text{ and } x < 5$ $\forall x : x < 0 \text{ or } x > -1$ $S = \{x : x < 3\}$
	Vertical line	... such that ... ...it is true that ...	Symbol following logical quantifier or used in defining a set	$\exists x   x > 4 \text{ and } x < 5$ $\forall x   x < 0 \text{ or } x > -1$ $S = \{x   x < 3\}$
::	Double colon	... averaged with ...	arithmetic mean	$3 :: 11 = 7$
$\infty$	lemniscate	... infinity ... increases without limit	Infinite summations Infinite sequence Limit	$\forall x : x < \infty$
( )	Parentheses	...quantity... ...list... ...set of coordinates... ...open interval	Denotes a quantity, list, set of coordinates, or an open interval	$(x+y) + z$ $(a_1, a_2, a_3, a_4)$ $(x,y,z)$ $(3,5)$
[ ]	Square brackets	... the quantity ... ... the closed interval ...	Denotes a quantity or a closed interval	$w + [(x+y) + z]$ $[2,4]$
( ]	Hybrid brackets	... the half-open interval ...	Denotes a half-open interval	$(2,4]$
[ )	Hybrid brackets	... the half-open interval ...	Denotes a half-open interval	$[2,4)$
{ }	Curly brackets	... the quantity ... ... the set ...	Denotes a quantity or a set	$E = \{2, 4, 6, 8, \dots\}$

=	Equal sign	... equals ...	Indicates two values are the same	$-(-6) = 6$ $2z^2 + 4z - 6 = 0$
$\propto$	Proportionality sign	... is proportional to ...	Indicates two variables change in direct proportion	$x \propto y$
$\sim$	Similarity sign	... is similar to ...	Indicates two objects are geometrically similar	$\triangle ABC \sim \triangle DEF$
$\approx$	Approximate equal sign	... is approximately equal to ...	Indicates two values are close to each other	$x + y \approx z$
$\neq$	Inequality sign	... is not equal to ...	Indicates two values are different	$x \neq y$
<	Inequality sign	... is less than ...	Indicates value on left is smaller than value on right	$2 < 4$ $x < y$
$\leq$	Inequality sign	... is less than or equal to ... ... is at most equal to ...	Indicates value on left is smaller than or equal to value on right	$x \leq y$
>	Inequality sign	... is greater than ...	Indicates value on left is larger than value on right	$4 > 1$ $x > y$
$\geq$	Inequality sign	... is greater than or equal to ...	Indicates value on left is larger than or equal to value on right	$x \geq y$
	absolute value sign	The absolute value of ...	Distance of value from origin in number line, plane, or space	$ -5  = 5$
$\Delta$	increment sign, Triangle symbol	the change in ... triangle ...	Indicates a small change, Denotes vertices of triangle	$m = \Delta y / \Delta x$ $\triangle ABC = \triangle DEF$
$\perp$	Perpendicularity symbol	... is perpendicular to ...	Geometry	$L \perp M$
//	Parallel symbol	... is parallel to ...	Geometry	$L // M$
$\angle$	angle symbol	Angle ...	Geometry	$\angle ABC = \angle DEF$
$\exists$	Existential quantifier	For some ... There exists a(n) ...	Logical statements	$\exists x : x > 4 \text{ and } x < 5$
$\forall$	Universal quantifier	For all ... For every ...	Logical statements	$\forall x : x < 0 \text{ or } x > -1$

$\neg$	Logical negation symbol	not ...	Logical statements	$\neg(\neg A) \iff A$
$\implies$	logical implication symbol	... implies ... If ... then ...	Logical statements	$A \implies B$
$\iff$	logical equivalence symbol	... is logically equivalent to ... ... if and only if ..	Logical statements	$A \iff B$
$\therefore$	Three dots	... therefore ... ... it follows that ...	Logical statements or mathematical proofs	$x = y \text{ and } y = z$ $\therefore x = z$
$\in$	Element-of symbol	... is an element of a set ...	Sets	$a \in A$
$\notin$	Not-element-of symbol	... is not an element of a set ...	Sets	$b \notin A$
$\subseteq$	Subset symbol	... is a subset of ...	Sets	$A \subseteq B$
$\subset$	Proper subset symbol	... is a proper subset of ...	Sets	$A \subset B$
$\cup$	Union symbol	... union ...	Sets	$A \cup B = B \cup A$
$\cap$	Intersection symbol	... intersect ... ... intersected with ...	Sets	$A \cap B = B \cap A$
$\emptyset$	Null symbol	The null set The empty set	Sets	$\emptyset = \{ \}$
$\aleph$	Hebrew aleph (uppercase)	Aleph ...	Transfinite cardinal	$\aleph_1 + \aleph_0 = \aleph_1$
$^\circ$	Degree symbol	... degree(s)	Angular measure Temperature	$\phi = 45^\circ$ $T = +20^\circ \text{C}$
$\theta$	Greek theta (lowercase)	... theta ...	Angular variable	$\theta = 90^\circ$
$\phi$	Greek phi (lowercase)	... phi ...	Angular variable	$\phi = 45^\circ$
$\lambda$	Greek lambda (lowercase)	... lambda ...	wavelength Ratio Eigenvalue Lebesgue measure	$\lambda = 70 \text{ cm}$ $\lambda = 3:1$
$\mu$	Greek mu (lowercase)	micro- ( $10^{-6}$ )	prefix multiplier	$C = 0.001 \mu\text{F}$
$\pi$	Greek pi (lowercase)	... pi ...	General science	$\pi \approx 3.14159$
$\Omega$	Greek omega (uppercase)	... omega ...	Volume of an object Ohms (resistance)	$R_2 = 330 \Omega$
$\omega$	Greek omega (lowercase)	... omega ...	Transfinite ordinal Angular velocity Period	$\omega = 36,000 \text{ rad/s}$ $\omega = 1/60 \text{ s}$

$\mathbb{N}, \mathbf{N}$	Enhanced or bold $N$	The set of natural numbers	Number theory Set theory	$\mathbb{N} = \{0, 1, 2, 3, \dots\}$
$\mathbb{Z}, \mathbf{Z}$	Enhanced or bold $Z$	The set of integers	Number theory Set theory	$\mathbb{Z} = \{0, 1, -1, 2, -2, 3, -3, \dots\}$
$\mathbb{Q}, \mathbf{Q}$	Enhanced or bold $Q$	The set of rational numbers	Number theory Set theory	$\mathbb{Q} = \{a/b \mid a \text{ and } b \text{ are in } \mathbb{Z}\}$
$\mathbb{R}, \mathbf{R}$	Enhanced or bold $R$	The set of real numbers	Number theory Set theory	What is the cardinality of $\mathbb{R}$ ?