Symbol	Name Read as Category	Explanation	Examples
$=$	equality is equal to; equals everywhere	$x = y$ means x and y represent the same thing or value.	$1 + 1 = 2$
$\neq$ <> !=	inequation is not equal to; does not equal everywhere	$x \neq y$ means that x and y do not represent the same thing or value. (*The symbols* != *and* <> *are primarily from computer science. They are avoided in mathematical texts.*)	$1 \neq 2$
$<$ $>$ $\ll$ $\gg$	strict inequality is less than, is greater than, is much less than, is much greater than order theory	$x < y$ means x is less than y. $x > y$ means x is greater than y. $x \ll y$ means x is much less than y. $x \gg y$ means x is much greater than y.	$3 < 4$ $5 > 4$. $0.003 \ll 1000000$
$\leq$ <= $\geq$ >=	inequality is less than or equal to, is greater than or equal to order theory	$x \leq y$ means x is less than or equal to y. $x \geq y$ means x is greater than or equal to y. (*The symbols* <= *and* >= *are primarily from computer science. They are avoided in mathematical texts.*)	$3 \leq 4$ and $5 \leq 5$ $5 \geq 4$ and $5 \geq 5$

∝	proportionality is proportional to; varies as everywhere	$y \propto x$ means that $y = kx$ for some constant k.	if $y = 2x$, then $y \propto x$
+	addition plus arithmetic	4 + 6 means the sum of 4 and 6.	2 + 7 = 9
	disjoint union the disjoint union of ... and ... set theory	$A_1 + A_2$ means the disjoint union of sets A_1 and A_2.	$A_1 = \{1, 2, 3, 4\}$ □ $A_2 = \{2, 4, 5, 7\}$ □ $A_1 + A_2 = \{(1,1), (2,1), (3,1), (4,1), (2,2), (4,2), (5,2), (7,2)\}$
−	subtraction minus arithmetic	9 − 4 means the subtraction of 4 from 9.	8 − 3 = 5
	negative sign negative ; minus arithmetic	−3 means the negative of the number 3.	−(−5) = 5
	set-theoretic complement minus; without set theory	$A - B$ means the set that contains all the elements of A that are not in B. \ can also be used for set-theoretic complement as discribed below.	{1,2,4} − {1,3,4} = {2}
×	multiplication times arithmetic	3 × 4 means the multiplication of 3 by 4.	7 × 8 = 56
	Cartesian product the Cartesian product of ... and ...; the direct product of ... and ... set theory	$X \times Y$ means the set of all ordered pairs with the first element of each pair selected from X and the second element selected from Y.	{1,2} × {3,4} = {(1,3),(1,4),(2,3),(2,4)}
	cross product cross vector algebra	$\mathbf{u} \times \mathbf{v}$ means the cross product of vectors **u** and **v**	(1,2,5) × (3,4,−1) = (−22, 16, − 2)
·	multiplication times arithmetic	3 · 4 means the multiplication of 3 by 4.	7 · 8 = 56
	dot product dot	$\mathbf{u} \cdot \mathbf{v}$ means the dot product of vectors **u** and **v**	(1,2,5) · (3,4,−1) = 6

	vector algebra		
÷ /	division divided by arithmetic	6 ÷ 3 or 6 ⁄ 3 means the division of 6 by 3.	2 ÷ 4 = .5 12 ⁄ 4 = 3
±	plus-minus plus or minus arithmetic	6 ± 3 means both 6 + 3 and 6 - 3.	The equation $x = 5 \pm \sqrt{4}$, has two solutions, $x = 7$ and $x = 3$.
±	plus-minus plus or minus measurement	10 ± 2 or eqivalently 10 ± 20% means the range from 10 − 2 to 10 + 2.	If $a = 100 \pm 1$ mm, then a is ≥ 99 mm and ≤ 101 mm.
∓	minus-plus minus or plus arithmetic	6 ± (3 ∓ 5) means both 6 + (3 - 5) and 6 - (3 + 5).	$\cos(x \pm y) = \cos(x)\cos(y) \mp \sin(x)\sin(y)$.
√	square root the principal square root of; square root real numbers	$\sqrt{x}$ means the positive number whose square is x.	$\sqrt{4} = 2$
√	complex square root the complex square root of … square root complex numbers	if $z = r \exp(\boldsymbol{i}\varphi)$ is represented in polar coordinates with $-\boldsymbol{\pi} < \varphi \leq \boldsymbol{\pi}$, then $\sqrt{z} = \sqrt{r}\exp(\boldsymbol{i}\,\varphi/2)$.	$\sqrt{-1} = \boldsymbol{i}$
|…|	absolute value or modulus absolute value (modulus) of numbers	$\|x\|$ means the distance along the real line (or across the complex plane) between x and zero.	$\|3\| = 3$ $\|-5\| = \|5\|$ $\|\boldsymbol{i}\| = 1$ $\|3 + 4\boldsymbol{i}\| = 5$
|…|	Euclidean distance Euclidean distance between; Euclidean norm of Geometry	$\|\mathbf{x} - \mathbf{y}\|$ means the Euclidean distance between $\mathbf{x}$ and $\mathbf{y}$.	For $\mathbf{x} = (1,1)$, and $\mathbf{y} = (4,5)$, $\|\mathbf{x} - \mathbf{y}\| = \sqrt{(1-4)^2 + (1-5)^2} = 5$
|…|	Determinant determinant of Matrix theory	$\|A\|$ means the determinant of the matrix $\mathbf{A}$	$\begin{vmatrix} 1 & 2 \\ 2 & 4 \end{vmatrix} = 0$

$\mid$	divides divides Number Theory	A single vertical bar is used to denote divisibility. $a \mid b$ means a divides b.	Since 15 = 3×5, it is true that $3\mid15$ and $5\mid15$.
!	factorial factorial combinatorics	$n\,!$ is the product $1 \times 2\times \ldots \times n$.	$4! = 1 \times 2 \times 3 \times 4 = 24$
T	transpose transpose matrix operations	Swap rows for columns	$A_{ij} = (A^T)_{ji}$
~	probability distribution has distribution statistics	$X \sim D$, means the random variable X has the probability distribution D.	*$X \sim N(0,1)$, the standard normal distribution*
	Row equivalence is row equivalent to Matrix theory	$A{\sim}B$ means that B can be generated by using a series of elementary row operations on A	$\begin{bmatrix}1 & 2\\2 & 4\end{bmatrix} \sim \begin{bmatrix}1 & 2\\0 & 0\end{bmatrix}$
⇒ → □	material implication implies; if … then propositional logic, Heyting algebra	$A \Rightarrow B$ means if A is true then B is also true; if A is false then nothing is said about B. → may mean the same as ⇒, or it may have the meaning for functions given below. □ may mean the same as □, or it may have the meaning for superset given below.	$x = 2 \;\Rightarrow\; x^2 = 4$ is true, but $x^2 = 4 \;\Rightarrow\; x = 2$ is in general false (since x could be −2).
⇔ ↔	material equivalence if and only if; iff propositional logic	$A \Leftrightarrow B$ means A is true if B is true and A is false if B is false.	$x + 5 = y + 2 \;\Leftrightarrow\; x + 3 = y$
¬ ˜	logical negation not propositional logic	The statement $\neg A$ is true if and only if A is false. A slash placed through another operator is the same as "¬" placed in front. (*The symbol ~ has many other uses, so ¬ or the slash notation is preferred.*)	$\neg(\neg A) \;\Leftrightarrow\; A$ $x \neq y \;\Leftrightarrow\; \neg(x = y)$

∧	logical conjunction or **meet** in a lattice and; min propositional logic, lattice theory	The statement A □ B is true if A and B are both true; else it is false. For functions A(x) and B(x), A(x) ∧ B(x) is used to mean min(A(x), B(x)).	$n < 4 \ \wedge \ n > 2 \ \Leftrightarrow \ n = 3$ when n is a natural number.
∨	logical disjunction or **join** in a lattice or; max propositional logic, lattice theory	The statement A ∨ B is true if A or B (or both) are true; if both are false, the statement is false. For functions A(x) and B(x), A(x) □ B(x) is used to mean max(A(x), B(x)).	$n \geq 4 \ \vee \ n \leq 2 \ \Leftrightarrow n \neq 3$ when n is a natural number.
□ ⊻	exclusive or xor propositional logic, Boolean algebra	The statement A □ B is true when either A or B, but not both, are true. A ⊻ B means the same.	(¬A) □ A is always true, A □ A is always false.
	direct sum direct sum of Abstract algebra	The direct sum is a special way of combining several modules into one general module (the symbol □ is used, ⊻ is only for logic).	Most commonly, for vector spaces U, V, and W, the following consequence is used: U = V □ W □ (U = V + W) □ (V ∩ W = ∅)
∀	universal quantification for all; for any; for each predicate logic	∀ x: P(x) means P(x) is true for all x.	$\forall\, n \in \mathbb{N}: n^2 \geq n.$
∃	existential quantification there exists predicate logic	∃ x: P(x) means there is at least one x such that P(x) is true.	$\exists\, n \in \mathbb{N}$: n is even.
∃!	uniqueness quantification there exists exactly one predicate logic	∃! x: P(x) means there is exactly one x such that P(x) is true.	$\exists!\, n \in \mathbb{N}: n + 5 = 2n.$
:= ≡	definition is defined as everywhere	$x := y$ or $x \equiv y$ means x is defined to be another name for y (*Some writers use ≡ to mean congruence*). $P :\equiv Q$ means P is defined to be logically equivalent to Q.	$\cosh x := (1/2)(\exp x + \exp(-x))$ A **xor** B :□ (A □ B) □ ¬(A □ B)

$:\equiv$			
$\cong$	congruence is congruent to geometry	△ABC ≅ △DEF means triangle ABC is congruent to (has the same measurements as) triangle DEF.	
$\equiv$	congruence relation ... is congruent to ... modulo ... modular arithmetic	a ≡ b (mod n) means a − b is divisible by n	5 ≡ 11 (mod 3)
{ , }	set brackets the set of … set theory	$\{a,b,c\}$ means the set consisting of a, b, and c.	$\mathbb{N} = \{ 1, 2, 3, \ldots\}$
{ : } { | }	set builder notation the set of … such that set theory	$\{x : P(x)\}$ means the set of all x for which $P(x)$ is true. $\{x \mid P(x)\}$ is the same as $\{x : P(x)\}$.	$\{n \in \mathbb{N} : n^2 < 20\} = \{ 1, 2, 3, 4\}$
$\varnothing$ { }	empty set the empty set set theory	$\varnothing$ means the set with no elements. { } means the same.	$\{n \in \mathbb{N} : 1 < n^2 < 4\} = \varnothing$
$\in$ $\notin$	set membership is an element of; is not an element of everywhere, set theory	$a \in S$ means a is an element of the set S; $a \notin S$ means a is not an element of S.	$(1/2)^{-1} \in \mathbb{N}$ $2^{-1} \notin \mathbb{N}$
$\subset$ $\subsetneq$	subset is a subset of set theory	(subset) $A \subset B$ means every element of A is also element of B. (proper subset) $A \subsetneq B$ means $A \subset B$ but $A \neq B$. *(Some writers use the symbol □ as if it were the same as □.)*	$(A \cap B) \subset A$ $\mathbb{N} \subsetneq \mathbb{Q}$ $\mathbb{Q} \subsetneq \mathbb{R}$
$\supset$	superset is a superset of set theory	$A \supset B$ means every element of B is also element of A.	$(A \cup B) \supset B$

$\supsetneq$		$A \supsetneq B$ means $A \supset B$ but $A \neq B$. (*Some writers use the symbol* □ *as if it were the same as* $\supsetneq$.)	$\mathbb{R} \supsetneq \mathbb{Q}$
$\triangle$	set-theoretic union the union of … and … union set theory	(exclusive) $A \triangle B$ means the set that contains all the elements from A, or all the elements from B, but not both. "A or B, but not both." (inclusive) A □ B means the set that contains all the elements from A, or all the elements from B, or all the elements from both A and B. "A or B or both".	A □ B □ (A □ B) = B (inclusive)
$\cap$	set-theoretic intersection intersected with; intersect set theory	$A \cap B$ means the set that contains all those elements that A and B have in common.	$\{x \in \mathbb{R} : x^2 = 1\} \cap \mathbb{N} = \{1\}$
Δ	symmetric difference symmetric difference set theory	$A \Delta B$ means the set of elements in exactly one of A or B.	$\{1,5,6,8\} \Delta \{2,5,8\} = \{1,2,6\}$
$\setminus$	set-theoretic complement minus; without set theory	$A \setminus B$ means the set that contains all those elements of A that are not in B. $-$ can also be used for set-theoretic complement as described above.	$\{1,2,3,4\} \setminus \{3,4,5,6\} = \{1,2\}$
( )	function application of set theory	$f(x)$ means the value of the function f at the element x.	If $f(x) := x^2$, then $f(3) = 3^2 = 9$.
	precedence grouping parentheses everywhere	Perform the operations inside the parentheses first.	(8/4)/2 = 2/2 = 1, but 8/(4/2) = 8/2 = 4.
$f{:}X \to Y$	function arrow from … to set theory, type theory	$f\colon X \to Y$ means the function f maps the set X into the set Y.	Let $f\colon \mathbb{Z} \to \mathbb{N}$ be defined by $f(x) := x^2$.

∘	function composition composed with set theory	$f∘g$ is the function, such that $(f∘g)(x) = f(g(x))$.	if $f(x) := 2x$, and $g(x) := x + 3$, then $(f∘g)(x) = 2(x + 3)$.
$\mathbb{N}$ **N**	natural numbers N numbers	**N** means { 1, 2, 3, ...}, but see the article on natural numbers for a different convention.	$\mathbb{N} = \{\|a\| : a \in \mathbb{Z}, a \neq 0\}$
$\mathbb{Z}$ **Z**	integers Z numbers	$\mathbb{Z}$ means {..., −3, −2, −1, 0, 1, 2, 3, ...} and $\mathbb{Z}^+$ means {1, 2, 3, ...} = $\mathbb{N}$.	$\mathbb{Z} = \{p, -p : p \in \mathbb{N}\} \cup \{0\}$
$\mathbb{Q}$ **Q**	rational numbers Q numbers	$\mathbb{Q}$ means $\{p/q : p \in \mathbb{Z}, q \in \mathbb{N}\}$.	$3.14000... \in \mathbb{Q}$ $\pi \notin \mathbb{Q}$
$\mathbb{R}$ **R**	real numbers R numbers	$\mathbb{R}$ means the set of real numbers.	$\pi \in \mathbb{R}$ $\sqrt{-1} \notin \mathbb{R}$
$\mathbb{C}$ **C**	complex numbers C numbers	$\mathbb{C}$ means $\{a + b\,\boldsymbol{i} : a,b \in \mathbb{R}\}$.	$\boldsymbol{i} = \sqrt{-1} \in \mathbb{C}$
	arbitrary constant C integral calculus	C can be any number, most likely unknown; usually occurs when calculating antiderivatives.	if $f(x) = 6x^2 + 4x$, then $F(x) = 2x^3 + 2x^2 + C$, where $F'(x) = f(x)$
$\mathbb{K}$ **K**	real or complex numbers K linear algebra	**K** means the statement holds substituting **K** for **R** and also for **C**.	$x^2 \in \mathbb{C}\, \forall x \in \mathbb{K}$ because $x^2 \in \mathbb{C}\, \forall x \in \mathbb{R}$ and $x^2 \in \mathbb{C}\, \forall x \in \mathbb{C}$.

∞	infinity infinity numbers	∞ is an element of the extended number line that is greater than all real numbers; it often occurs in limits.	$\lim_{x\to 0} 1/\lvert x\rvert = \infty$
$\lVert\ldots\rVert$	norm norm of length of linear algebra	$\lVert x \rVert$ is the norm of the element x of a normed vector space.	$\lVert x + y \rVert \leq \lVert x \rVert + \lVert y \rVert$
$\sum$	summation sum over … from … to … of arithmetic	$\sum_{k=1}^{n} a_k$ means $a_1 + a_2 + \ldots + a_n$.	$\sum_{k=1}^{4} k^2 = 1^2 + 2^2 + 3^2 + 4^2 = 1 + 4 + 9 + 16 = 30$
$\prod$	product product over … from … to … of arithmetic	$\prod_{k=1}^{n} a_k$ means $a_1 a_2 \cdots a_n$.	$\prod_{k=1}^{4} (k+2) = (1+2)(2+2)(3+2)(4+2) = 3 \times 4 \times 5 \times 6 = 360$
	Cartesian product the Cartesian product of; the direct product of set theory	$\prod_{i=0}^{n} Y_i$ means the set of all (n+1)-tuples $(y_0, \ldots, y_n)$.	$\prod_{n=1}^{3} \mathbb{R} = \mathbb{R} \times \mathbb{R} \times \mathbb{R} = \mathbb{R}^3$
$\coprod$	coproduct coproduct over … from … to … of category theory		
$'$ $\bullet$	derivative … prime derivative of calculus	$f'(x)$ is the derivative of the function f at the point x, i.e., the slope of the tangent to f at x. The dot notation indicates a time derivative. That is . $\dot{x}(t) = \frac{\partial}{\partial t} x(t)$	If $f(x) := x^2$, then $f'(x) = 2x$
$\int$	indefinite integral or antiderivative indefinite integral of the antiderivative of calculus	$\int f(x)\,dx$ means a function whose derivative is f.	$\int x^2\,dx = x^3/3 + C$
	definite integral integral from … to … of … with respect to calculus	$\int_a^b f(x)\,dx$ means the signed area between the x-axis and the graph of the function f between $x = a$ and $x = b$.	$\int_0^b x^2\,dx = b^3/3;$

∇	gradient del, nabla, gradient of calculus	$\nabla f(x_1, \ldots, x_n)$ is the vector of partial derivatives $(\partial f / \partial x_1, \ldots, \partial f / \partial x_n)$.	If $f(x,y,z) := 3xy + z^2$, then $\nabla f = (3y, 3x, 2z)$
∂	partial differential partial, d calculus	With $f(x_1, \ldots, x_n)$, $\partial f/\partial x_i$ is the derivative of f with respect to x_i, with all other variables kept constant.	If $f(x,y) := x^2y$, then $\partial f/\partial x = 2xy$
	boundary boundary of topology	∂M means the boundary of M	$\partial\{x : \|x\| \leq 2\} = \{x : \|x\| = 2\}$
$\perp$	perpendicular is perpendicular to geometry	$x \perp y$ means x is perpendicular to y; or more generally x is orthogonal to y.	If $l \perp m$ and $m \perp n$ then $l \parallel n$.
	bottom element the bottom element lattice theory	x = □ means x is the smallest element.	□x : x □ □ = □
$\parallel$	parallel is parallel to geometry	$x \parallel y$ means x is parallel to y.	If $l \parallel m$ and $m \parallel n$ then $l \parallel n$.
$\models$	entailment entails model theory	$A \models B$ means the sentence A entails the sentence B, that is every model in which A is true, B is also true.	$A \models A$ □ $\neg A$
$\vdash$	inference infers or is derived from propositional logic, predicate logic	$x \vdash y$ means y is derived from x.	$A \rightarrow B \vdash \neg B \rightarrow \neg A$
$\lhd$	normal subgroup is a normal subgroup of group theory	$N \lhd G$ means that N is a normal subgroup of group G.	$Z(G) \lhd G$
/	quotient group mod group theory	G/H means the quotient of group G modulo its subgroup H.	$\{0, a, 2a, b, b+a, b+2a\} / \{0, b\} = \{\{0, b\}, \{a, b+a\}, \{2a, b+2a\}\}$
	quotient set mod set theory	$A/\sim$ means the set of all $\sim$ equivalence classes in A.	If we define $\sim$ by $x \sim y \Leftrightarrow x-y \in \mathbf{Z}$, then $\mathbf{R}/\sim = \{\{x+n : n \in \mathbf{Z}\} : x \in (0,1]\}$

≈	isomorphism is isomorphic to group theory	$G \approx H$ means that group G is isomorphic to group H	$Q / \{1, -1\} \approx V$, where Q is the quaternion group and V is the Klein four-group.
	approximately equal is approximately equal to everywhere	$x \approx y$ means x is approximately equal to y	$\pi \approx 3.14159$
~	same order of magnitude roughly similar poorly approximates Approximation theory	$m \sim n$, means the quantities m and n have the general size. *(Note that ~ is used for an approximation that is poor, otherwise use ≈ .)*	$2 \sim 5$ $8 \times 9 \sim 100$ but $\pi^2 \approx 10$
〈 , 〉 (|) < , > · :	inner product inner product of vector algebra	$\langle x,y \rangle$ means the inner product of x and y as defined in an inner product space. For spatial vectors, the dot product notation, $x \cdot y$ is common. For matricies, the colon notation may be used.	The standard inner product between two vectors $x = (2, 3)$ and $y = (-1, 5)$ is: $\langle x, y \rangle = 2\times-1 + 3\times5 = 13$ $A{:}B = \sum_{i,j} A_{ij}B_{ij}$
⊗	tensor product tensor product of linear algebra	$V \otimes U$ means the tensor product of V and U.	$\{1, 2, 3, 4\} \otimes \{1,1,2\} = \{\{1, 2, 3, 4\}, \{1, 2, 3, 4\}, \{2, 4, 6, 8\}\}$
*	convolution convolution	$f * g$ means the convolution of f and g.	$(f * g)(t) = \int f(\tau)g(t-\tau)\,d\tau$
$\bar{x}$	mean overbar statistics	$\bar{x}$ is the mean (average value of x_i).	$x = \{1, 2, 3, 4, 5\}; \bar{x} = 3$.

$\triangleq$	delta equal to equal by definition everywhere	$\triangleq$ means equal by definition. When $\triangleq$ is used, equality is not true generally, but rather equality is true under certain assumptions that are taken in context.	$p(x_1, x_2, ..., x_n) \triangleq \prod_{i=1}^{n} p(x_i \mid x_{\pi_i})$.