List of mathematical symbols

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This list is incomplete; you can help by expanding it.

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This is a list of symbols found within all branches of mathematics to express a formula or to represent a constant.

When reading the list, it is important to recognize that a mathematical concept is independent of the symbol chosen to represent it. For many of the symbols below, the symbol is usually synonymous with the corresponding concept (ultimately an arbitrary choice made as a result of the cumulative history of mathematics), but in some situations a different convention may be used. For example, depending on context, "≡" may represent congruence or a definition. Further, in mathematical logic, numerical equality is sometimes represented by "≡" instead of "=", with the latter representing equality of well-formed formulas. In short, convention dictates the meaning.

Each symbol is shown both in HTML, whose display depends on the browser's access to an appropriate font installed on the particular device, and in TeX, as an image.

Contents [hide]

Symbols [edit]

Symbol in HTML	Symbol in TeX	Name Read as Category	Explanation	E
=	$=$	equality is equal to; equals everywhere	$x = y$ means x and y represent the same thing or value.	$2 = 2$ $1 + 1 = 2$
≠	$\neq$	inequality 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 forms !=, /= or <> are generally used in programming languages where ease of typing and use of ASCII text is preferred.)*	$2 + 2 \neq 5$
< >	$<$ $>$	strict inequality is less than, is greater than order theory	$x < y$ means x is less than y. $x > y$ means x is greater than y.	$3 < 4$ $5 > 4$
		proper subgroup is a proper subgroup of group theory	$H < G$ means H is a proper subgroup of G.	$5Z < Z$ $A_3 < S_3$
≪ ≫	$\ll$ $\gg$	significant (strict) inequality is much less than, is much greater than order theory	*x* ≪ *y* means *x* is much less than *y*. *x* ≫ *y* means *x* is much greater than *y*.	0.003 ≪ 1000000
		asymptotic comparison is of smaller order than, is of greater order than analytic number theory	*f* ≪ *g* means the growth of *f* is asymptotically bounded by *g*. *(This is I. M. Vinogradov's notation. Another notation is the Big O notation, which looks like f* = O(*g*).)	$x \ll e^x$
≤ ≥	$\leq$ $\geq$	inequality is less than or equal to, is greater than or equal to order theory	*x* ≤ *y* means *x* is less than or equal to *y*. *x* ≥ *y* means *x* is greater than or equal to *y*. (The forms <= and >= are generally used in programming languages, where ease of typing and use of ASCII text is preferred.)	3 ≤ 4 and 5 ≤ 5 5 ≥ 4 and 5 ≥ 5
		subgroup is a subgroup of group theory	*H* ≤ *G* means *H* is a subgroup of *G*.	**Z** ≤ **Z** $A_3 \leq S_3$
		reduction is reducible to computational complexity theory	*A* ≤ *B* means the problem *A* can be reduced to the problem *B*. Subscripts can be added to the ≤ to indicate what kind of reduction.	If $\exists f \in F \ . \ \forall x \in \mathbb{N} \ . \ x \in A \Leftarrow$ then $A \leq_F B$
≦ ≧	$\leqq$ $\geqq$	congruence relation ...is less than ... is greater than... modular arithmetic	7*k* ≡ 28 (mod 2) is only true if *k* is an even integer. Assume that the problem requires *k* to be non-negative; the domain is defined as 0 ≦ *k* ≦ ∞.	10*a* ≡ 5 (mod 5) for 1 ≦ *a* ≦ 10
		vector inequality ... is less than or equal... is greater than or equal...	*x* ≦ *y* means that each component of vector *x* is less than or equal to each corresponding component of vector *y*. *x* ≧ *y* means that each component of vector *x* is greater than or equal to each corresponding component of vector *y*.	

		order theory	*It is important to note that x ≨ y remains true if every element is equal. However, if the operator is changed, x ≤ y is true if and only if x ≠ y is also true.*	
≺ ≻	$\prec$ $\succ$	Karp reduction is Karp reducible to; is polynomial-time many-one reducible to computational complexity theory	$L_1 \prec L_2$ means that the problem L_1 is Karp reducible to L_2.[1]	If $L_1 \prec L_2$ and $L_2 \in$ **P**, then $L_1 \in$ **P**.
∝	$\propto$	proportionality is proportional to; varies as everywhere	*y* ∝ *x* means that *y* = *kx* for some constant *k*.	if *y* = 2*x*, then *y* ∝ *x*.
		Karp reduction[2] is Karp reducible to; is polynomial-time many-one reducible to computational complexity theory	*A* ∝ *B* means the problem *A* can be polynomially reduced to the problem *B*.	If $L_1 \propto L_2$ and $L_2 \in$ **P**, then $L_1 \in$ **P**.
+	$+$	addition plus; add 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 = {3, 4, 5, 6} ∧ A_2 = {7, 8, 9, 10} ⇒ $A_1 + A_2$ = {(3,1), (4,1), (5,1), (6,1), (7,2),
−	$-$	subtraction minus; take; subtract arithmetic	9 − 4 means the subtraction of 4 from 9.	8 − 3 = 5
		negative sign negative; minus; the opposite of 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 described below.*)	{1,2,4} − {1,3,4} = {2}
±	$\pm$	plus-minus plus or minus arithmetic	6 ± 3 means both 6 + 3 and 6 − 3.	The equation *x* = 5 ± √4, has two solutio
		plus-minus plus or minus measurement	10 ± 2 or equivalently 10 ± 20% means the range from 10 − 2 to 10 + 2.	If *a* = 100 ± 1 mm, then *a* ≥ 99 mm and *a*
∓	$\mp$	minus-plus minus or plus arithmetic	6 ± (3 ∓ 5) means 6 + (3 − 5) and 6 − (3 + 5).	cos(*x* ± *y*) = cos(*x*) cos(*y*) ∓ sin(*x*) sin(*y*)
×	$\times$	multiplication times; multiplied by arithmetic	3 × 4 means the multiplication of 3 by 4. (The symbol * is generally used in programming languages, where ease of typing and use of ASCII text is preferred.)	7 × 8 = 56
		Cartesian product the Cartesian product of ... and ...; the direct product of ... and ... set theory	*X*×*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 linear algebra	**u** × **v** means the cross product of vectors **u** and **v**	(1,2,5) × (3,4,−1) = (−22, 16, − 2)
		group of units the group of units of ring theory	$R^\times$ consists of the set of units of the ring *R*, along with the operation of multiplication. *This may also be written R* as described below, or U(R).*	$(\mathbb{Z}/5\mathbb{Z})^\times = \{[1],[2],[3],[4]\} \cong C_4$
*	$*$	multiplication times; multiplied by arithmetic	*a* * *b* means the product of *a* and *b*. (*Multiplication can also be denoted with × or ·, or even simple juxtaposition.* * *is generally used where ease of typing and use of ASCII text is preferred, such as programming languages.*)	4 * 3 means the product of 4 and 3, or 1:
		convolution convolution; convolved with functional analysis	*f* * *g* means the convolution of *f* and *g*.	$(f*g)(t) = \int_{-\infty}^{\infty} f(\tau)g(t-\tau)\,$
		complex conjugate conjugate complex numbers	*z** means the complex conjugate of *z*. ($\bar{z}$ *can also be used for the conjugate of z, as described below.*)	$(3+4i)^* = 3-4i$

		group of units the group of units of ring theory	R^* consists of the set of units of the ring *R*, along with the operation of multiplication. *This may also be written* $R^\times$ *as described above, or U*(*R*).	$(\mathbb{Z}/5\mathbb{Z})^* = \{[1],[2],[3],[4]\} \cong C_4$
		hyperreal numbers the (set of) hyperreals non-standard analysis	***R** means the set of hyperreal numbers. Other sets can be used in place of **R**.	***N** is the hypernatural numbers.
		Hodge dual Hodge dual; Hodge star linear algebra	**v* means the Hodge dual of a vector *v*. If *v* is a *k*-vector within an *n*-dimensionaloriented inner product space, then **v* is an (*n*−*k*)-vector.	If $\{e_i\}$ are the standard basis vectors of
·	$\cdot$	multiplication times; multiplied by arithmetic	3 · 4 means the multiplication of 3 by 4.	7 · 8 = 56
		dot product dot linear algebra	**u** · **v** means the dot product of vectors **u** and **v**	(1,2,5) · (3,4,−1) = 6
		placeholder (silent) functional analysis	A · means a placeholder for an argument of a function. Indicates the functional nature of an expression without assigning a specific symbol for an argument.	$\|\cdot\|$
⊗	$\otimes$	tensor product, tensor product of modules tensor product of linear algebra	$V \otimes U$ means the tensor product of *V* and *U*.[3] $V \otimes_R U$ means the tensor product of modules *V* and *U* over the ring *R*.	{1, 2, 3, 4} ⊗ {1, 1, 2} = {{1, 2, 3, 4}, {1, 2, 3, 4}, {2, 4, 6, 8}}
	$\owedge$	Kulkarni–Nomizu product Kulkarni–Nomizu product tensor algebra	Derived from the tensor product of two symmetric type (0,2) tensors; it has the algebraic symmetries of the Riemann tensor. $f = g \owedge h$ has components $f_{\alpha\beta\gamma\delta} = g_{\alpha\gamma}h_{\beta\delta} + g_{\beta\delta}h_{\alpha\gamma} - g_{\alpha\delta}h_{\beta\gamma} - g_{\beta\gamma}h_{\alpha\delta}$.	
÷ ⁄	$\div$ $/$	division (Obelus) divided by; over arithmetic	6 ÷ 3 or 6 ⁄ 3 means the division of 6 by 3.	2 ÷ 4 = 0.5 12 ⁄ 4 = 3
		quotient group mod group theory	*G* / *H* means the quotient of group *G* modulo its subgroup *H*.	{0, *a*, 2*a*, *b*, *b*+*a*, *b*+2*a*} / {0, *b*} = {{0, *b*},
		quotient set mod set theory	*A*/~ means the set of all ~ equivalence classes in *A*.	If we define ~ by x ~ y ⇔ x − y ∈ ℤ, then ℝ/~ = { {*x* + *n* : *n* ∈ ℤ } : x ∈ [0,1) }
√	$\surd$ $\sqrt{}$	square root the (principal) square root of real numbers	$\sqrt{x}$ means the nonnegative number whose square is x.	$\sqrt{4} = 2$
		complex square root the (complex) square root of complex numbers	if $z = r\,\exp(i\phi)$ is represented in polar coordinates with $-\pi < \phi \leq \pi$, then $\sqrt{z} = \sqrt{r}\exp(i\phi/2)$.	$\sqrt{-1} = i$
x̅	$\bar{x}$	mean overbar; … bar statistics	$\bar{x}$ (often read as "x bar") is the mean (average value of x_i).	$x = \{1,2,3,4,5\}; \bar{x} = 3$.
		complex conjugate conjugate complex numbers	$\bar{z}$ means the complex conjugate of *z*. (*z* can also be used for the conjugate of z, as described above.*)	$\overline{3+4i} = 3-4i$.
		finite sequence, tuple finite sequence, tuple model theory	$\overline{a}$ means the finite sequence/tuple $(a_1, a_2, ..., a_n)$.	$\overline{a} := (a_1, a_2, ..., a_n)$.
		algebraic closure algebraic closure of field theory	$\overline{F}$ is the algebraic closure of the field *F*.	The field of algebraic numbers is someti closure of the rational numbers $\mathbb{Q}$.
		topological closure (topological) closure of topology	$\overline{S}$ is the topological closure of the set *S*. *This may also be denoted as* cl(*S*) *or* Cl(*S*).	In the space of the real numbers, $\overline{\mathbb{Q}} =$ numbers).
â	$\hat{a}$	unit vector hat geometry	$\mathbf{\hat{a}}$ (pronounced "a hat") is the normalized version of vector $\mathbf{a}$, having length 1.	
		estimator estimator for statistics	$\hat{\theta}$ is the estimator or the estimate for the parameter θ.	The estimator $\hat{\mu} = \frac{\sum_i x_i}{n}$ produces a
		absolute value; modulus absolute value of; modulus of numbers	|*x*| means the distance along the real line (or across the complex plane) betweenx and zero.	|3| = 3 |–5| = |5| = 5 | *i* | = 1 | 3 + 4*i* | = 5
		Euclidean norm or Euclidean length or		For **x** = (3,-4)

<table>
<tr><th></th><th></th><th></th><th></th><th></th></tr>
<tr><td rowspan="3">|…|</td><td rowspan="3">|…|</td><td>magnitude
Euclidean norm of
geometry</td><td>|x| means the (Euclidean) length of vector x.</td><td>For x = (3, −4)
$|\mathbf{x}| = \sqrt{3^2 + (-4)^2} = 5$</td></tr>
<tr><td>determinant
determinant of
matrix theory</td><td>|A| means the determinant of the matrix A</td><td>$\begin{vmatrix} 1 & 2 \\ 2 & 9 \end{vmatrix} = 5$</td></tr>
<tr><td>cardinality
cardinality of;
size of;
order of
set theory</td><td>|X| means the cardinality of the set X.

(# may be used instead as described below.)</td><td>|{3, 5, 7, 9}| = 4.</td></tr>
<tr><td rowspan="2">‖…‖</td><td rowspan="2">‖…‖</td><td>norm
norm of;
length of
linear algebra</td><td>‖ x ‖ means the norm of the element x of a normed vector space.[4]</td><td>‖ x + y ‖ ≤ ‖ x ‖ + ‖ y ‖</td></tr>
<tr><td>nearest integer function
nearest integer to
numbers</td><td>‖x‖ means the nearest integer to x.

(This may also be written [x], ⌊x⌉, nint(x) or Round(x).)</td><td>‖1‖ = 1, ‖1.6‖ = 2, ‖−2.4‖ = −2, ‖3.49‖ =</td></tr>
<tr><td rowspan="3">|</td><td rowspan="3">|</td><td>conditional event
given
probability</td><td>P(A|B) means the probability of the event a occurring given that b occurs.</td><td>if X is a uniformly random day of the yea</td></tr>
<tr><td>restriction
restriction of … to …;
restricted to
set theory</td><td>$f|_A$ means the function f restricted to the set A, that is, it is the function withdomain A ∩ dom(f) that agrees with f.</td><td>The function f : R → R defined by f(x) = x</td></tr>
<tr><td>such that
such that;
so that
everywhere</td><td>| means "such that", see ":" (described below).</td><td>S = {(x,y) | 0 < y < f(x)}
The set of (x,y) such that y is greater tha</td></tr>
<tr><td>∣
∤</td><td>|
∤</td><td>divisor, divides
divides
number theory</td><td>a ∣ b means a divides b.
a ∤ b means a does not divide b.

(The symbol ∣ can be difficult to type, and its negation is rare, so a regular but slightly shorter vertical bar | character is often used instead.)</td><td>Since 15 = 3×5, it is true that 3 ∣ 15 and</td></tr>
<tr><td>||</td><td>||</td><td>exact divisibility
exactly divides
number theory</td><td>p^a || n means p^a exactly divides n (i.e. p^a divides n but p^{a+1} does not).</td><td>2^3 || 360.</td></tr>
<tr><td rowspan="2">∥
∦
⋕</td><td rowspan="2">∥
∦</td><td>parallel
is parallel to
geometry</td><td>x ∥ y means x is parallel to y.
x ∦ y means x is not parallel to y.
x ⋕ y means x is equal and parallel to y.

(The symbol ∥ can be difficult to type, and its negation is rare, so two regular but slightly longer vertical bar || characters are often used instead.)</td><td>If l ∥ m and m ⊥ n then l ⊥ n.</td></tr>
<tr><td>incomparability
is incomparable to
order theory</td><td>x ∥ y means x is incomparable to y.</td><td>{1,2} ∥ {2,3} under set containment.</td></tr>
<tr><td rowspan="3">#</td><td rowspan="3">#</td><td>cardinality
cardinality of;
size of;
order of
set theory</td><td>#X means the cardinality of the set X.

(|…| may be used instead as described above.)</td><td>#{4, 6, 8} = 3</td></tr>
<tr><td>connected sum
connected sum of;
knot sum of;
knot composition of
topology, knot theory</td><td>A#B is the connected sum of the manifolds A and B. If A and B are knots, then this denotes the knot sum, which has a slightly stronger condition.</td><td>$A\#S^m$ is homeomorphic to A, for any mai</td></tr>
<tr><td>primorial
primorial
number theory</td><td>n# is product of all prime numbers less than or equal to n.</td><td>12# = 2 × 3 × 5 × 7 × 11 = 2310</td></tr>
<tr><td>ℵ</td><td>ℵ</td><td>aleph number
aleph
set theory</td><td>$\aleph_\alpha$ represents an infinite cardinality (specifically, the α-th one, where α is an ordinal).</td><td>|ℕ| = $\aleph_0$, which is called aleph-null.</td></tr>
<tr><td>ℶ</td><td>ℶ</td><td>beth number
beth
set theory</td><td>$\beth_\alpha$ represents an infinite cardinality (similar to ℵ, but ℶ does not necessarily index all of the numbers indexed by ℵ.).</td><td>$\beth_1 = |P(\mathbb{N})| = 2^{\aleph_0}$.</td></tr>
<tr><td>𝔠</td><td>𝔠</td><td>cardinality of the continuum
cardinality of the continuum;
c;
cardinality of the real numbers
set theory</td><td>The cardinality of $\mathbb{R}$ is denoted by $|\mathbb{R}|$ or by the symbol 𝔠 (a lowercase Frakturletter C).</td><td>$\mathfrak{c} = \beth_1$</td></tr>
<tr><td></td><td></td><td>such that
such that;
so that
everywhere</td><td>: means "such that", and is used in proofs and the set-builder notation (described below).</td><td>∃ n ∈ ℕ: n is even.</td></tr>
<tr><td></td><td></td><td>field extension</td><td></td><td></td></tr>
</table>

:	:	[field extension](#) extends; over field theory	*K* : *F* means the field *K* extends the field *F*. *This may also be written as K ≥ F.*	ℝ : ℚ
		inner product of matrices inner product of linear algebra	*A* : *B* means the Frobenius inner product of the matrices *A* and *B*. *The general inner product is denoted by* ⟨*u*, *v*⟩, ⟨*u* | *v*⟩ *or* (*u* | *v*), *as described below. For spatial vectors, the* dot product *notation*, *x·y is common.* See alsobra–ket notation.	$A:B=\sum_{i,j}A_{ij}B_{ij}$
		index of a subgroup index of subgroup group theory	The index of a subgroup H in a group G is the "relative size" of H in G: equivalently, the number of "copies" (cosets) of H that fill up G	$\lvert G:H\rvert=\frac{\lvert G\rvert}{\lvert H\rvert}$
!	!	logical negation not propositional logic	The statement !*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* ! *is primarily from computer science. It is avoided in mathematical texts, where the notation ¬A is preferred.*)	!(!*A*) ⇔ *A* *x* ≠ *y* ⇔ !(*x* = *y*)
		factorial factorial combinatorics	*n*! means the product 1 × 2 × ... × *n*.	$4!=1\times2\times3\times4=24$
$\binom{}{}$	( )	combination; binomial coefficient *n* choose *k* combinatorics	$\binom{n}{k}=\frac{n!/(n-k)!}{k!}=\frac{(n-k+1)\cdots(n-2)\cdot(n-1)\cdot n}{k!}$ means (in the case of *n* = positive integer) the number of combinations of *k*elements drawn from a set of *n* elements. (*This may also be written as* C(*n*, *k*), C(*n*; *k*), $_nC_k$, $^n\mathbf{C}_k$, or $\left\langle\begin{matrix}n\\k\end{matrix}\right\rangle$.)	$\binom{73}{5}=\frac{73!/(73-5)!}{5!}=\frac{69\cdot 7}{1\cdot}$ $\binom{.5}{7}=\frac{-5.5\cdot-4.5\cdot-3.5\cdot-}{1\cdot2\cdot3\cdot4\cdot}$
	(( ))	multiset coefficient *u* multichoose *k* combinatorics	$\left(\!\!\binom{u}{k}\!\!\right)=\binom{u+k-1}{k}=\frac{(u+k-1)!/(u-1)!}{k!}$ (when *u* is positive integer) means reverse or rising binomial coefficient.	$\left(\!\!\binom{-5.5}{7}\!\!\right)=\frac{-5.5\cdot-4.5\cdot-3.5}{1\cdot2\cdot3}$
~	∼	probability distribution has distribution statistics	*X* ~ *D*, means the random variable *X* has the probability distribution *D*.	*X* ~ *N*(0,1), the standard normal distribut
		row equivalence is row equivalent to matrix theory	*A*~*B* means that *B* can be generated by using a series of elementary row operations on *A*	$\begin{bmatrix}1&2\\2&4\end{bmatrix}\sim\begin{bmatrix}1&2\\0&0\end{bmatrix}$
		same order of magnitude roughly similar; poorly approximates approximation theory	*m* ~ *n* means the quantities *m* and *n* have the same order of magnitude, or general size. (*Note that ~ is used for an approximation that is poor, otherwise use ≈ .*)	2 ~ 5 8 × 9 ~100 but π^2 ≈ 10
		similarity is similar to[5] geometry	△ABC ~ △DEF means triangle ABC is similar to (has the same shape) triangle DEF.	
		asymptotically equivalent is asymptotically equivalent to asymptotic analysis	*f* ~ *g* means $\lim_{n\to\infty}\frac{f(n)}{g(n)}=1$.	x ~ x+1
		equivalence relation are in the same equivalence class everywhere	*a* ~ *b* means $b\in[a]$ (and equivalently $a\in[b]$).	1 ~ 5 mod 4
≈	≈	approximately equal is approximately equal to everywhere	*x* ≈ *y* means *x* is approximately equal to *y*. *This may also be written* ≃, ≅, ~, ♎ (Libra Symbol), *or* ≒.	π ≈ 3.14159
		isomorphism is isomorphic to group theory	*G* ≈ *H* means that group *G* is isomorphic (structurally identical) to group *H*. (≅ *can also be used for isomorphic, as described below.*)	*Q* / {1, −1} ≈ *V*, where *Q* is the quaternion group and *V* i
≀	≀	wreath product wreath product of … by … group theory	*A* ≀ *H* means the wreath product of the group *A* by the group *H*. *This may also be written A* $_{\text{wr}}$ *H.*	$S_n\wr Z_2$ is isomorphic to the automorph vertices.
◅ ▻	◅ ▻	normal subgroup is a normal subgroup of group theory	*N* ◅ *G* means that *N* is a normal subgroup of group *G*.	*Z*(*G*) ◅ *G*
		ideal is an ideal of ring theory	*I* ◅ *R* means that *I* is an ideal of ring *R*.	(2) ◅ **Z**
		antijoin the antijoin of relational algebra	*R* ▻ *S* means the antijoin of the relations *R* and *S*, the tuples in *R* for which there is not a tuple in *S* that is equal on their common attribute names.	*R* ▻ *S* = *R* - *R* ⋉ *S*
⋉		semidirect product the semidirect product of	*N* $\rtimes_\varphi$ *H* is the semidirect product of *N* (a normal subgroup) and *H* (a subgroup), with respect to φ. Also, if *G* = *N* $\rtimes_\varphi$ *H*, then *G* is said to split over *N*.	$D_{2n}\cong C_n\rtimes C_2$

⋊	⋉ ⋊	group theory	(⋊ *may also be written the other way round, as* ⋉, *or as* ×.)	
		semijoin the semijoin of relational algebra	*R* ⋉ *S* is the semijoin of the relations *R* and *S*, the set of all tuples in *R* for which there is a tuple in *S* that is equal on their common attribute names.	$R \ltimes S = \prod_{a_1,\ldots,a_n}(R \bowtie S)$
⋈	⋈	natural join the natural join of relational algebra	*R* ⋈ *S* is the natural join of the relations *R* and *S*, the set of all combinations of tuples in *R* and *S* that are equal on their common attribute names.	
∴	∴	therefore therefore; so; hence everywhere	Sometimes used in proofs before logical consequences.	All humans are mortal. Socrates is a hun
∵	∵	because because; since everywhere	Sometimes used in proofs before reasoning.	11 is prime ∵ it has no positive integer fa
■ □ ▮	■ □ ▶	end of proof QED; tombstone; Halmos symbol everywhere	Used to mark the end of a proof. (*May also be written* Q.E.D.)	
▮ ▸		D'Alembertian non-Euclidean Laplacian vector calculus	It is the generalisation of the Laplace operator in the sense that it is the differential operator which is invariant under the isometry group of the underlying space and it reduces to the Laplace operator if restricted to time independent functions.	$\Box = \frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \frac{\partial^2}{\partial x^2} - \frac{\partial^2}{\partial y^2} - \frac{\partial^2}{\partial z}$
↯		downwards zigzag arrow contradiction; this contradicts that everywhere	Denotes that contradictory statements have been inferred. For clarity, the exact point of contradiction can be appended.	Statement: Every finite, non-empty, orde assume that X is a finite, non-empty, or some $x_1 \in X$, there exists an $x_2 \in$ an $x_3 \in X$ with $x_2 < x_3$, and so on. ↯ X is finite.
⇒ → ⊃	⇒ → ⊃	material implication implies; if … then propositional logic, Heyting algebra	*A* ⇒ *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* ⇒,[6] *or it may have the meaning for* superset *given below.*)	*x* = 2 ⇒ x^2 = 4 is true, but x^2 = 4 ⇒ *x* =
⇔ ↔	⇔ ↔	material equivalence if and only if; iff propositional logic	*A* ⇔ *B* means *A* is true if *B* is true and *A* is false if *B* is false.	*x* + 5 = *y* + 2 ⇔ *x* + 3 = *y*
¬ ˜	¬ ~	logical negation not propositional logic	The statement ¬*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. Computer scientists will often use ! but this is avoided in mathematical texts.*)	¬(¬*A*) ⇔ *A* *x* ≠ *y* ⇔ ¬(*x* = *y*)
∧	∧	logical conjunction or meet in a lattice and; min; meet 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 ∧ *n* >2 ⇔ *n* = 3 when *n* is a natu
		wedge product wedge product; exterior product exterior algebra	*u* ∧ *v* means the wedge product of any multivectors *u* and *v*. In three-dimensional Euclidean space the wedge product and the cross product of two vectors are each other's Hodge dual.	$u \wedge v = *(u \times v) \quad \text{if } u, v \in \mathbb{R}^3$
		exponentiation … (raised) to the power of … everywhere	*a* ^ *b* means *a* raised to the power of *b* (*a ^ b is more commonly written* a^b. *The symbol ^ is generally used in programming languages where ease of typing and use of plain ASCII text is preferred.*)	2^3 = 2^3 = 8
∨	∨	logical disjunction or **join** in a lattice or; max;	The statement *A* ∨ *B* is true if *A* or *B* (or both) are true; if both are false, the statement is false.	*n* ≥ 4 ∨ *n* ≤ 2 ⇔ *n* ≠ 3 when *n* is a natu

		join propositional logic, lattice theory	For functions *A*(x) and *B*(x), *A*(x) ∨ *B*(x) is used to mean max(A(x), B(x)).	
⊕ ⊻	⊕ ⊻	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
		direct sum direct sum of abstract algebra	The direct sum is a special way of combining several objects into one general object. (*The bun symbol* ⊕, *or the* coproduct *symbol* ∐, is used; ⊻ is only for logic.)	Most commonly, for vector spaces *U*, *V*, *U* = *V* ⊕ *W* ⇔ (*U* = *V* + *W*) ∧ (*V* ∩ *W* = {0
∀	∀	universal quantification for all; for any; for each predicate logic	∀ *x*: *P*(*x*) means *P*(*x*) is true for all *x*.	∀ *n* ∈ ℕ: $n^2 \geq n$.
∃	∃	existential quantification there exists; there is; there are predicate logic	∃ *x*: *P*(*x*) means there is at least one *x* such that *P*(*x*) is true.	∃ *n* ∈ 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.	∃! *n* ∈ ℕ: *n* + 5 = 2*n*.
=: := ≡ :⇔ ≜ ≝ ≐	=: := ≡ :⇔ ≜ ≝ ≐	definition is defined as; is equal by definition to everywhere	*x* := *y*, *y* =: *x* or *x* ≡ *y* means *x* is defined to be another name for *y*, under certain assumptions taken in context. (*Some writers use* ≡ *to mean* *congruence*). *P* :⇔ *Q* means *P* is defined to be logically equivalent to *Q*.	$\cosh x := \frac{e^x + e^{-x}}{2}$
≅	≅	congruence is congruent to geometry	△ABC ≅ △DEF means triangle ABC is congruent to (has the same measurements as) triangle DEF.	
		isomorphic is isomorphic to abstract algebra	*G* ≅ *H* means that group *G* is isomorphic (structurally identical) to group *H*. (≈ *can also be used for isomorphic, as described above*.)	$\mathbb{R}^2 \cong \mathbb{C}$.
≡	≡	congruence relation ... is congruent to ... modulo ... modular arithmetic	*a* ≡ *b* (mod *n*) means *a* − *b* is divisible by *n*	5 ≡ 2 (mod 3)
{ , }	{ , }	set brackets the set of … set theory	{*a*,*b*,*c*} means the set consisting of *a*, *b*, and *c*.[7]	ℕ = { 1, 2, 3, …}
{ : } { | } { ; }	{ : } { | } { ; }	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.[7] {*x* | *P*(*x*)} is the same as {*x* : *P*(*x*)}.	{*n* ∈ ℕ : n^2 < 20} = { 1, 2, 3, 4}
∅ { }	∅ ∅ {}	empty set the empty set set theory	∅ means the set with no elements.[7] { } means the same.	{*n* ∈ ℕ : 1 < n^2 < 4} = ∅
∈	∈	set membership is an element of;	*a* ∈ *S* means *a* is an element of the set *S*;[7] *a* ∉ *S* means *a* is not an	$(1/2)^{-1}$ ∈ ℕ

∉	∉	is not an element of everywhere, set theory	element of *S*.[7]	2^{-1} ∉ ℕ
∋	∋	such that symbol such that mathematical logic	often abbreviated as "s.t."; : and | are also used to abbreviate "such that". The use of ∋ goes back to early mathematical logic and its usage in this sense is declining.	Choose x ∋ 2|x and 3|x. (Here | is use
		set membership contains as an element set theory	S∋e means the same thing as e∈S, where S is a set and e is an element of S.	
∌	∌	set membership does not contain as an element set theory	S∌e means the same thing as e∉S, where S is a set and e is not an element of S.	
⊆ ⊂	⊆ ⊂	subset is a subset of set theory	(subset) *A* ⊆ *B* means every element of *A* is also an element of *B*.[8] (proper subset) *A* ⊂ *B* means *A* ⊆ *B* but *A* ≠ *B*. (*Some writers use the symbol* ⊂ *as if it were the same as* ⊆.)	(*A* ∩ *B*) ⊆ *A* ℕ ⊂ ℚ ℚ ⊂ ℝ
⊇ ⊃	⊇ ⊃	superset is a superset of set theory	*A* ⊇ *B* means every element of *B* is also an element of *A*. *A* ⊃ *B* means *A* ⊇ *B* but *A* ≠ *B*. (*Some writers use the symbol* ⊃ *as if it were the same as* ⊇.)	(*A* ∪ *B*) ⊇ *B* ℝ ⊃ ℚ
∪	∪	set-theoretic union the union of … or …; union set theory	*A* ∪ *B* means the set of those elements which are either in *A*, or in *B*, or in both.[8]	*A* ⊆ *B* ⇔ (*A* ∪ *B*) = *B*
∩	∩	set-theoretic intersection intersected with; intersect set theory	*A* ∩ *B* means the set that contains all those elements that *A* and *B* have in common.[8]	{*x* ∈ ℝ : x^2 = 1} ∩ ℕ = {1}
∆ ⊖	∆ ⊖	symmetric difference symmetric difference set theory	A ∆ B (or A ⊖ B) means the set of elements in exactly one of *A* or *B*. (*Not to be confused with delta*, Δ, *described below.*)	{1,5,6,8} ∆ {2,5,8} = {1,2,6} {3,4,5,6} ⊖ {1,2,5,6} = {1,2,3,4}
\	\	set-theoretic complement minus; without set theory	*A* \ *B* means the set that contains all those elements of *A* that are not in *B*.[8] (− *can also be used for set-theoretic complement as described above.*)	{1,2,3,4} \ {3,4,5,6} = {1,2}
→	→	function arrow from … to set theory, type theory	*f*: *X* → *Y* means the function *f* maps the set *X* into the set *Y*.	Let *f*: ℤ → ℕ∪{0} be defined by *f*(*x*) := x^2
↦	↦	function arrow maps to set theory	*f*: *a* ↦ *b* means the function *f* maps the element *a* to the element *b*.	Let *f*: *x* ↦ *x*+1 (the successor function).
∘	∘	function composition composed with set theory	*f*∘*g* is the function, such that (*f*∘*g*)(*x*) = *f*(*g*(*x*)).[9]	if *f*(*x*) := 2*x*, and *g*(*x*) := *x* + 3, then (*f*∘*g*)(
∘	∘	Hadamard product entrywise product linear algebra	For two matrices (or vectors) of the same dimensions $A, B \in \mathbb{R}^{m\times n}$ the Hadamard product is a matrix of the same dimensions $A \circ B \in \mathbb{R}^{m\times n}$ with elements given by $(A \circ B)_{i,j} = (A)_{i,j} \cdot (B)_{i,j}$. This is often used in matrix based programming such as MATLAB where the operation is done by A.*B	$\begin{bmatrix}1&2\\2&4\end{bmatrix}\circ\begin{bmatrix}1&2\\0&0\end{bmatrix}=\begin{bmatrix}1&4\\0&0\end{bmatrix}$
ℕ **N**	ℕ **N**	natural numbers N; the (set of) natural numbers numbers	**N** means either { 0, 1, 2, 3, ...} or { 1, 2, 3, ...}. *The choice depends on the area of mathematics being studied; e.g. number theorists prefer the latter; analysts, set theorists and computer scientists prefer the former. To avoid confusion, always check an author's definition of* **N**. *Set theorists often use the notation* ω *(for least infinite ordinal) to denote the set of natural numbers (including zero), along with the standard ordering relation* ≤.	ℕ = {|*a*| : *a* ∈ ℤ} **or** ℕ = {|*a*| > 0: *a* ∈ ℤ}
ℤ **Z**	ℤ **Z**	integers Z; the (set of) integers numbers	ℤ means {..., −3, −2, −1, 0, 1, 2, 3, ...}. $\mathbb{Z}^+$ or $\mathbb{Z}^>$ means {1, 2, 3, ...} . $\mathbb{Z}^*$ or $\mathbb{Z}^\geq$ means {0, 1, 2, 3, ...} .	ℤ = {*p*, −*p* : *p* ∈ ℕ ∪ {0}}
$\mathbb{Z}_n$ $\mathbb{Z}_p$	$\mathbb{Z}_n$ $\mathbb{Z}_p$ $\mathbf{Z}_n$	integers mod *n* Z_n; the (set of) integers modulo*n* numbers	$\mathbb{Z}_n$ means {[0], [1], [2], ...[*n*−1]} with addition and multiplication modulo *n*. *Note that any letter may be used instead of n, such as p. To avoid confusion with p-adic numbers, use* ℤ/*p*ℤ *or* ℤ/(*p*) *instead.*	$\mathbb{Z}_3$ = {[0], [1], [2]}

$\mathbf{Z}_n$ $\mathbf{Z}_p$	$\mathbf{Z}_p$	*p*-adic integers the (set of) *p*-adic integers numbers	*Note that any letter may be used instead of p, such as n or l.*	
ℙ **P**	ℙ **P**	projective space P; the projective space; the projective line; the projective plane topology	ℙ means a space with a point at infinity.	$\mathbb{P}^1,\mathbb{P}^2$
		probability the probability of probability theory	ℙ(*X*) means the probability of the event *X* occurring. *This may also be written as* P(*X*), Pr(*X*), P[*X*] or Pr[*X*].	If a fair coin is flipped, ℙ(Heads) = ℙ(Tai
		Power set the Power set of Powerset	Given a set S, the power set of S is the set of all subsets of the set S. The power set of S is denoted by P(S).	The power set P({0, 1, 2}) is the set of al P({0, 1, 2}) = {∅, {0}, {1}, {2}, {0, 1}, {0, 2
ℚ **Q**	ℚ **Q**	rational numbers Q; the (set of) rational numbers; the rationals numbers	ℚ means {*p*/*q* : *p* ∈ ℤ, *q* ∈ ℕ}.	3.14000... ∈ ℚ π ∉ ℚ
ℝ **R**	ℝ **R**	real numbers R; the (set of) real numbers; the reals numbers	ℝ means the set of real numbers.	π ∈ ℝ √(−1) ∉ ℝ
ℂ **C**	ℂ **C**	complex numbers C; the (set of) complex numbers numbers	ℂ means {*a* + *b i* : *a*,*b* ∈ ℝ}.	*i* = √(−1) ∈ ℂ
ℍ **H**	ℍ **H**	quaternions or Hamiltonian quaternions H; the (set of) quaternions numbers	ℍ means {*a* + *b* **i** + *c* **j** + *d* **k** : *a*,*b*,*c*,*d* ∈ ℝ}.	
O	O	Big O notation big-oh of Computational complexity theory	The Big O notation describes the limiting behavior of a function, when the argument tends towards a particular value or infinity.	If f(x) = $6x^4 - 2x^3 + 5$ and g(x) = x^4, then
∞	∞	infinity infinity numbers	∞ is an element of the extended number line that is greater than all real numbers; it often occurs in limits.	$\lim_{x\to 0} \frac{1}{\lvert x\rvert} = \infty$
⌊…⌋	⌊…⌋	floor floor; greatest integer; entier numbers	⌊*x*⌋ means the floor of *x*, i.e. the largest integer less than or equal to *x*. (*This may also be written* [*x*], floor(*x*) *or* int(*x*).)	⌊4⌋ = 4, ⌊2.1⌋ = 2, ⌊2.9⌋ = 2, ⌊−2.6⌋ = −3
⌈…⌉	⌈…⌉	ceiling ceiling numbers	⌈*x*⌉ means the ceiling of *x*, i.e. the smallest integer greater than or equal to *x*. (*This may also be written* ceil(*x*) *or* ceiling(*x*).)	⌈4⌉ = 4, ⌈2.1⌉ = 3, ⌈2.9⌉ = 3, ⌈−2.6⌉ = −2
⌊…⌉	⌊…⌉	nearest integer function nearest integer to numbers	⌊*x*⌉ means the nearest integer to *x*. (*This may also be written* [*x*], ||*x*||, nint(*x*) *or* Round(*x*).)	⌊2⌉ = 2, ⌊2.6⌉ = 3, ⌊-3.4⌉ = -3, ⌊4.49⌉ = 4
[:]	[:]	degree of a field extension the degree of field theory	[*K* : *F*] means the degree of the extension *K* : *F*.	[ℚ(√2) : ℚ] = 2 [ℂ : ℝ] = 2 [ℝ : ℚ] = ∞
[ ]		equivalence class the equivalence class of abstract algebra	[*a*] means the equivalence class of *a*, i.e. {*x* : *x* ~ *a*}, where ~ is an equivalence relation. [*a*]$_R$ means the same, but with *R* as the equivalence relation.	Let *a* ~ *b* be true iff *a* ≡ *b* (mod 5). Then [2] = {…, −8, −3, 2, 7, …}.
		floor floor; greatest integer; entier numbers	[*x*] means the floor of *x*, i.e. the largest integer less than or equal to *x*. (*This may also be written* ⌊*x*⌋, floor(*x*) *or* int(*x*). *Not to be confused with the nearest integer function, as described below.*)	[3] = 3, [3.5] = 3, [3.99] = 3, [−3.7] = −4
		nearest integer function nearest integer to numbers	[*x*] means the nearest integer to *x*. (*This may also be written* ⌊*x*⌉, ||*x*||, nint(*x*) *or* Round(*x*). *Not to be confused with the floor function, as described above.*)	[2] = 2, [2.6] = 3, [-3.4] = -3, [4.49] = 4

[,] [, ,]	[ ] [,] [, ,]	Iverson bracket 1 if true, 0 otherwise propositional logic	[*S*] maps a true statement *S* to 1 and a false statement *S* to 0.	[0=5]=0, [7>0]=1, [2 ∈ {2,3,4}]=1, [5 ∈ {2
		image image of … under … everywhere	*f*[*X*] means { *f*(*x*) : *x* ∈ *X* }, the image of the function *f* under the set *X* ⊆ dom(*f*). (*This may also be written as* f(X) *if there is no risk of confusing the image of funder X with the function application f of X. Another notation is* Im *f, the image of funder its domain.*)	$\sin[\mathbb{R}] = [-1, 1]$
		closed interval closed interval order theory	$[a, b] = \{x \in \mathbb{R} : a \leq x \leq b\}$.	0 and 1/2 are in the interval [0,1].
		commutator the commutator of group theory, ring theory	[*g*, *h*] = $g^{-1}h^{-1}gh$ (or $ghg^{-1}h^{-1}$), if *g*, *h* ∈ *G* (a group). [*a*, *b*] = *ab* − *ba*, if *a*, *b* ∈ *R* (a ring or commutative algebra).	x^y = *x*[*x*, *y*] (group theory). [*AB*, *C*] = *A*[*B*, *C*] + [*A*, *C*]*B* (ring theory).
		triple scalar product the triple scalar product of vector calculus	[**a**, **b**, **c**] = **a** × **b** · **c**, the scalar product of **a** × **b** with **c**.	[**a**, **b**, **c**] = [**b**, **c**, **a**] = [**c**, **a**, **b**].
( ) (,)	( ) (,)	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.
		image image of … under … everywhere	*f*(*X*) means { *f*(*x*) : *x* ∈ *X* }, the image of the function *f* under the set *X* ⊆ dom(*f*). (*This may also be written as* f[X] *if there is a risk of confusing the image of funder X with the function application f of X. Another notation is* Im *f, the image of funder its domain.*)	$\sin(\mathbb{R}) = [-1, 1]$
		precedence grouping parentheses everywhere	Perform the operations inside the parentheses first.	(8/4)/2 = 2/2 = 1, but 8/(4/2) = 8/2 = 4.
		tuple tuple; *n*-tuple; ordered pair/triple/etc; row vector; sequence everywhere	An ordered list (or sequence, or horizontal vector, or row vector) of values. (*Note that the notation* (*a*,*b*) *is ambiguous: it could be an ordered pair or an open interval. Set theorists and computer scientists often use angle brackets* ⟨ ⟩*instead of parentheses.*)	(*a*, *b*) is an ordered pair (or 2-tuple). (*a*, *b*, *c*) is an ordered triple (or 3-tuple). ( ) is the empty tuple (or 0-tuple).
		highest common factor highest common factor; greatest common divisor; hcf; gcd number theory	(*a*, *b*) means the highest common factor of *a* and *b*. (*This may also be written* hcf(*a*, *b*) *or* gcd(*a*, *b*).)	(3, 7) = 1 (they are coprime); (15, 25) =
(,)] , [	(,)] , [	open interval open interval order theory	$(a, b) = \{x \in \mathbb{R} : a < x < b\}$. (*Note that the notation* (*a*,*b*) *is ambiguous: it could be an ordered pair or an open interval. The notation*]a,b[*can be used instead.*)	4 is not in the interval (4, 18). (0, +∞) equals the set of positive real nu
(,]] ,]	(,]] ,]	left-open interval half-open interval; left-open interval order theory	$(a, b] = \{x \in \mathbb{R} : a < x \leq b\}$.	(−1, 7] and (−∞, −1]
[,) [, [	[,) [, [	right-open interval half-open interval; right-open interval order theory	$[a, b) = \{x \in \mathbb{R} : a \leq x < b\}$.	[4, 18) and [1, +∞)
⟨⟩ ⟨,⟩	⟨ ⟩ ⟨ , ⟩	inner product inner product of linear algebra	⟨*u*,*v*⟩ means the inner product of *u* and *v*, where *u* and *v* are members of an inner product space. *Note that the notation* ⟨*u*, *v*⟩ *may be ambiguous: it could mean the inner product or the linear span.* *There are many variants of the notation, such as* $\langle u \mid v\rangle$ *and* $(u \mid v)$*, which are described below. For spatial vectors, the dot product notation, x·y is common. For matrices, the colon notation A : B may be used.* *As* ⟨ *and* ⟩ *can be hard to type, the more "keyboard friendly" forms* < *and* > *are sometimes seen. These are avoided in mathematical texts.*	The standard inner product between two ⟨x, y⟩ = 2 × −1 + 3 × 5 = 13
		average average of statistics	let S be a subset of N for example, $\langle S\rangle$ represents the average of all the element in S.	for a time series :*g*(*t*) (*t* = 1, 2,...) we can define the structure functions $S_q($ $S_q = \langle \lvert g(t+\tau) - g(t)\rvert^q \rangle_t$
		linear span (linear) span of; linear hull of linear algebra	⟨*S*⟩ means the span of *S* ⊆ *V*. That is, it is the intersection of all subspaces of *V*which contain *S*. $\langle u_1, u_2, \ldots\rangle$is shorthand for $\langle\{u_1, u_2, \ldots\}\rangle$. *Note that the notation* ⟨*u*, *v*⟩ *may be ambiguous: it could mean the inner productor the linear span.* *The span of S may also be written as* Sp(*S*).	$\left\langle \begin{pmatrix}1\\0\\0\end{pmatrix}, \begin{pmatrix}0\\1\\0\end{pmatrix}, \begin{pmatrix}0\\0\\1\end{pmatrix} \right\rangle = \mathbb{R}^3$.
		subgroup generated by a		

		subgroup generated by a set the subgroup generated by group theory	$\langle S \rangle$ means the smallest subgroup of *G* (where *S* ⊆ *G*, a group) containing every element of *S*. $\langle g_1, g_2, \dots, \rangle$ is shorthand for $\langle \{g_1, g_2, \dots\} \rangle$.	In S_3, $\langle (1\ 2) \rangle = \{id,\ (1\ 2)\}$ and $\langle($
		tuple tuple; *n*-tuple; ordered pair/triple/etc; row vector; sequence everywhere	An ordered list (or sequence, or horizontal vector, or row vector) of values. (*The notation* (*a*,*b*) *is often used as well.*)	$\langle a, b \rangle$ is an ordered pair (or 2-tuple). $\langle a, b, c \rangle$ is an ordered triple (or 3-tuple) $\langle \rangle$ is the empty tuple (or 0-tuple).
$\langle\mid\rangle$ $(\mid)$	$\langle \mid \rangle$ $(\mid)$	inner product inner product of linear algebra	$\langle u \mid v \rangle$ means the inner product of *u* and *v*, where *u* and *v* are members of aninner product space.[10] $(u \mid v)$ means the same. *Another variant of the notation is* ⟨*u*, *v*⟩ *which is described above. For spatial vectors, the* dot product *notation, x·y is common. For matrices, the colon notation A : B may be used. As* ⟨ *and* ⟩ *can be hard to type, the more "keyboard friendly" forms* < *and* > *are sometimes seen. These are avoided in mathematical texts.*	
$\mid\rangle$	$\mid \rangle$	ket vector the ket …; the vector … Dirac notation	$\mid\varphi\rangle$ means the vector with label *φ*, which is in a Hilbert space.	A qubit's state can be represented as $\alpha\mid($ $\alpha\mid^2 + \mid\beta\mid^2 = 1$.
$\langle\mid$	$\langle \mid$	bra vector the bra …; the dual of … Dirac notation	$\langle\varphi\mid$ means the dual of the vector $\mid\varphi\rangle$, a linear functional which maps a ket $\mid\psi\rangle$ onto the inner product $\langle\varphi\mid\psi\rangle$.	
∑	$\sum$	summation sum over … from … to … of arithmetic	$\sum_{k=1}^{n} a_k$ means $a_1 + a_2 + \cdots + a_n$.	$\sum_{k=1}^{4} k^2 = 1^2 + 2^2 + 3^2 + 4^2 ::=$
∏	$\prod$	product product over … from … to … of arithmetic	$\prod_{k=1}^{n} a_k$ means $a_1 a_2 \dots a_n$.	$\prod_{k=1}^{4} (k+2) = (1+2)(2+2)(3$
		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, …, 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	A general construction which subsumes the disjoint union of sets and of topological spaces, the free product of groups, and the direct sum of modules and vector spaces. The coproduct of a family of objects is essentially the "least specific" object to which each object in the family admits a morphism.	
Δ	Δ	delta delta; change in calculus	Δ*x* means a (non-infinitesimal) change in *x*. (*If the change becomes infinitesimal,* δ *and even* d *are used instead. Not to be confused with the symmetric difference, written* ∆, *above.*)	$\frac{\Delta y}{\Delta x}$ is the gradient of a straight line
		Laplacian Laplace operator vector calculus	The Laplace operator is a second order differential operator in n-dimensionalEuclidean space	If *f* is a twice-differentiable real-valued fu by $\Delta f = \nabla^2 f = \nabla \cdot \nabla f$
δ	δ	Dirac delta function Dirac delta of hyperfunction	$\delta(x) = \begin{cases} \infty, & x = 0 \\ 0, & x \neq 0 \end{cases}$	δ(x)
		Kronecker delta Kronecker delta of hyperfunction	$\delta_{ij} = \begin{cases} 1, & i = j \\ 0, & i \neq j \end{cases}$	δ_{ij}
		Functional derivative Functional derivative of Differential operators	$\left\langle \frac{\delta F[\varphi(x)]}{\delta\varphi(x)}, f(x) \right\rangle = \int \frac{\delta F[\varphi(x)]}{\delta\varphi(x')} f(x') dx' = \lim_{\varepsilon \to 0} \frac{F[\varphi(x) + \varepsilon f(x)] - F[\varphi(x)]}{\varepsilon} = \left. \frac{d}{d\epsilon} F[\varphi + \epsilon f] \right\vert_{\epsilon=0}.$	$\frac{\delta V(r)}{\delta\rho(r')} = \frac{1}{4\pi\epsilon_0 \vert r - r' \vert}.$
∂	∂	partial derivative partial; d calculus	$\partial f/\partial x_i$ means the partial derivative of *f* with respect to x_i, where *f* is a function on (x_1, …, x_n).	If $f(x,y) := x^2 y$, then $\partial f/\partial x = 2xy$
		boundary boundary of topology	∂*M* means the boundary of *M*	$\partial\{x : \Vert x\Vert \leq 2\} = \{x : \Vert x\Vert = 2\}$
		degree of a polynomial degree of algebra	∂*f* means the degree of the polynomial *f*. (*This may also be written* deg *f*.)	$\partial(x^2 - 1) = 2$
		gradient del; nabla; gradient of	$\nabla f(x_1, \dots, x_n)$ is the vector of partial derivatives ($\partial f / \partial x_1$, …, $\partial f / \partial x_n$).	If $f(x,y,z) := 3xy + z^2$, then $\nabla f = (3y, 3x, 2$

		vector calculus		
∇	∇	divergence del dot; divergence of vector calculus	$\nabla \cdot \vec{v} = \frac{\partial v_x}{\partial x} + \frac{\partial v_y}{\partial y} + \frac{\partial v_z}{\partial z}$	If $\vec{v} := 3xy\mathbf{i} + y^2z\mathbf{j} + 5\mathbf{k}$, then ∇
		curl curl of vector calculus	$\nabla \times \vec{v} = \left(\frac{\partial v_z}{\partial y} - \frac{\partial v_y}{\partial z}\right)\mathbf{i} + \left(\frac{\partial v_x}{\partial z} - \frac{\partial v_z}{\partial x}\right)\mathbf{j} + \left(\frac{\partial v_y}{\partial x} - \frac{\partial v_x}{\partial y}\right)\mathbf{k}$	If $\vec{v} := 3xy\mathbf{i} + y^2z\mathbf{j} + 5\mathbf{k}$, then ∇
′	$\prime$	derivative … prime; derivative of calculus	*f* ′(*x*) means the derivative of the function *f* at the point *x*, i.e., the slope of thetangent to *f* at *x*. (*The single-quote character* ' *is sometimes used instead, especially in ASCII text.*)	If *f*(*x*) := x^2, then *f* ′(*x*) = 2*x*
•	$\cdot$	derivative … dot; time derivative of calculus	$\dot{x}$ means the derivative of *x* with respect to time. That is $\dot{x}(t) = \frac{\partial}{\partial t}x(t)$.	If *x*(*t*) := t^2, then $\dot{x}(t) = 2t$.
∫	$\int$	indefinite integral orantiderivative indefinite integral of the antiderivative of calculus	∫ *f*(*x*) d*x* means a function whose derivative is *f*.	∫x^2 d*x* = x^3/3 + *C*
		definite integral integral from … to … of … with respect to calculus	$\int_a^b$ *f*(*x*) d*x* means the signed area between the *x*-axis and the graph of thefunction *f* between *x* = *a* and *x* = *b*.	$\int_a^b x^2 dx = \frac{b^3 - a^3}{3}$
		line integral line/ path/ curve/ integral of… along… calculus	$\int_C$ *f* d*s* means the integral of *f* along the curve *C*, $\int_a^b f(\mathbf{r}(t))\lvert\mathbf{r}'(t)\rvert\, dt$, where **r** is a parametrization of *C*. (*If the curve is closed, the symbol* ∮ *may be used instead, as described below.*)	
∮	$\oint$	Contour integral; closed line integral contour integral of calculus	Similar to the integral, but used to denote a single integration over a closed curve or loop. It is sometimes used in physics texts involving equations regardingGauss's Law, and while these formulas involve a closed surface integral, the representations describe only the first integration of the volume over the enclosing surface. Instances where the latter requires simultaneous double integration, the symbol ∯ would be more appropriate. A third related symbol is the closed volume integral, denoted by the symbol ∰. The contour integral can also frequently be found with a subscript capital letter *C*, $\oint_C$, denoting that a closed loop integral is, in fact, around a contour *C*, or sometimes dually appropriately, a circle *C*. In representations of Gauss's Law, a subscript capital *S*, $\oint_S$, is used to denote that the integration is over a closed surface.	If *C* is a Jordan curve about 0, then $\oint_C$
π	π	projection Projection of relational algebra	$\pi_{a_1,\ldots,a_n}(R)$ restricts R to the $\{a_1,\ldots,a_n\}$ attribute set.	$\pi_{\text{Age,Weight}}(\text{Person})$
		Pi pi; 3.1415926…; ≈22÷7 mathematical constant	Used in various formulas involving circles; π is equivalent to the amount of area a circle would take up in a square of equal width with an area of 4 square units, roughly 3.14/4. It is also the ratio of the circumference to the diameter of a circle.	A=πR^2=314.16→R=10
σ	σ	selection Selection of relational algebra	The selection $\sigma_{a\theta b}(R)$ selects all those tuples in R for which θ holds between the a and the b attribute. The selection $\sigma_{a\theta v}(R)$ selects all those tuples in $R$for which θ holds between the a attribute and the value v.	$\sigma_{Age\geq 34}(Person)$ $\sigma_{Age=Weight}(Person)$
<: <·	$<:$ $<\cdot$	cover is covered by order theory	*x* <• *y* means that *x* is covered by *y*.	{1, 8} <• {1, 3, 8} among the subsets of {
		subtype is a subtype of type theory	T_1 <: T_2 means that T_1 is a subtype of T_2.	If *S* <: *T* and *T* <: *U* then *S* <: *U* (transitivi
†	$\dagger$	conjugate transpose conjugate transpose; adjoint; Hermitian adjoint/conjugate/transpose matrix operations	$A^\dagger$ means the transpose of the complex conjugate of *A*.[11] *This may also be written* A^{*T}, A^{T*}, A^*, $\overline{A}^T$ *or* $\overline{A^T}$.	If *A* = (a_{ij}) then $A^\dagger$ = ($\overline{a_{ji}}$).
T	T	transpose transpose matrix operations	A^T means *A*, but with its rows swapped for columns. *This may also be written A′*, A^t *or* A^{tr}.	If *A* = (a_{ij}) then A^T = (a_{ji}).
⊤	$\top$	top element the top element lattice theory	⊤ means the largest element of a lattice.	∀*x* : *x* ∨ ⊤ = ⊤
		top type the top type; top type theory	⊤ means the top or universal type; every type in the type system of interest is a subtype of top.	∀ types *T*, *T* <: ⊤

⊥	$\perp$	perpendicular is perpendicular to geometry	*x* ⊥ *y* means *x* is perpendicular to *y*; or more generally *x* is orthogonal to *y*.	If *l* ⊥ *m* and *m* ⊥ *n* in the plane, then *l* ||
		orthogonal complement orthogonal/ perpendicular complement of; perp linear algebra	$W^\perp$ means the orthogonal complement of *W* (where *W* is a subspace of theinner product space *V*), the set of all vectors in *V* orthogonal to every vector in*W*.	Within $\mathbb{R}^3$, $(\mathbb{R}^2)^\perp \cong \mathbb{R}$.
		coprime is coprime to number theory	*x* ⊥ *y* means *x* has no factor greater than 1 in common with *y*.	34 ⊥ 55.
		independent is independent of probability	*A* ⊥ *B* means *A* is an event whose probability is independent of event *B*.	If *A* ⊥ *B*, then P(*A*|*B*) = P(*A*).
		bottom element the bottom element lattice theory	⊥ means the smallest element of a lattice.	∀*x* : *x* ∧ ⊥ = ⊥
		bottom type the bottom type; bot type theory	⊥ means the bottom type (a.k.a. the zero type or empty type); bottom is the subtype of every type in the type system.	∀ types *T*, ⊥ <: *T*
		comparability is comparable to order theory	*x* ⊥ *y* means that *x* is comparable to *y*.	{*e*, *π*} ⊥ {1, 2, *e*, 3, *π*} under set contain
⊧	$\models$	entailment entails model theory	*A* ⊧ *B* means the sentence *A* entails the sentence *B*, that is in every model in which *A* is true, *B* is also true.	*A* ⊧ *A* ∨ ¬*A*
⊢	$\vdash$	inference infers; is derived from propositional logic,predicate logic	*x* ⊢ *y* means *y* is derivable from *x*.	*A* → *B* ⊢ ¬*B* → ¬*A*.
		partition is a partition of number theory	*p* ⊢ *n* means that *p* is a partition of *n*.	(4,3,1,1) ⊢ 9, $\sum_{\lambda \vdash n} (f_\lambda)^2 = n!$.
⋮	$\vdots$	vertical ellipsis vertical ellipsis everywhere	Denotes that certain constants and terms are missing out (e.g. for clarity) and that only the important terms are being listed.	$P(r,t) = \chi \vdots E(r,t_1)E(r,t_2)E(r$
𝔼 *E*	$\mathbb{E}$ E	expected value expected value probability theory	the value of a random variable one would "expect" to find if one could repeat the random variable process an infinite number of times and take the average of the values obtained	$\mathbb{E}[X] = \frac{x_1p_1 + x_2p_2 + \cdots + x_k}{p_1 + p_2 + \cdots + p_k}$