

Comprehensive List of **Mathematical Symbols**



MATH VAULT

Comprehensive List of Mathematical Symbols

For the corresponding [web guides](#), see [Mathematical Symbols](#).

Table of Contents

1	Constant	3
1.1	Key Mathematical Numbers	3
1.2	Key Mathematical Sets	4
1.3	Key Mathematical Infinities	5
1.4	Other Key Mathematical Objects	6
2	Variables	6
2.1	Variables for Numbers	6
2.2	Variables in Geometry	7
2.3	Variables in Calculus	7
2.4	Variables in Linear Algebra	8
2.5	Variables in Set Theory and Logic	8
2.6	Variables in Probability and Statistics	9
3	Delimiters	10
3.1	Common Delimiters	10
3.2	Other Delimiters	10
4	Operators	11

4.1	Common Operators	11
4.2	Function-related Operators	12
4.3	Elementary Functions	12
4.4	Algebra-related Operators	13
4.5	Geometry-related Operators	14
4.6	Logic-related Operators	15
4.7	Set-related Operators	16
4.8	Vector-related Operators	16
4.9	Matrix-related Operators	17
4.10	Probability-related Operators	18
4.11	Statistics-related Operators	18
4.12	Key Probability Functions and Distributions . .	19
4.13	Calculus-related Operators	20
5	Relational Symbols	21
5.1	Equality-based Relational Symbols	21
5.2	Comparison-based Relational Symbols	21
5.3	Number-related Relational Symbols	22
5.4	Geometry-related Relational Symbols	22
5.5	Set-related Relational Symbols	22
5.6	Logic-related Relational Symbols	23
5.7	Probability-related Relational Symbols	23
5.8	Calculus-related Relational Symbols	24
6	Notational Symbols	24
6.1	Common Notational Symbols	24
6.2	Notational Symbols in Geometry and Trigonometry	25
6.3	Notational Symbols in Calculus	25
6.4	Notational Symbols in Probability and Statistics	26
7	Additional Resources	26

1 Constant

1.1 Key Mathematical Numbers

Symbols (Explanation)	LaTeX Code	Example
0 (Zero, additive identity)	$\$0\$$	$3 + 0 = 3$
1 (One, multiplicative identity)	$\$1\$$	$5 \times 1 = 5$
$\sqrt{2}$ (Square root of 2)	$\$\sqrt{2}\$$	$(\sqrt{2} + 1)^2 = 3 + 2\sqrt{2}$
e (Euler's constant)	$\$e\$$	$\ln(e^2) = 2$
π (Pi, Archimedes' constant)	$\$\pi\$$	$\frac{\pi^2}{6} = \frac{1}{1^2} + \frac{1}{2^2} + \dots$
φ (Phi, golden ratio)	$\$\varphi\$$	$\varphi = \frac{1 + \sqrt{5}}{2}$
i (Imaginary unit)	$\$i\$$	$(1 + i)^2 = 2i$

1.2 Key Mathematical Sets

Symbols (Explanation)	LaTeX Code	Example
\emptyset (Empty set)	$\$\varnothing\$$	$ \emptyset = 0$
\mathbb{N} (Set of natural numbers)	$\$\mathbb{N}\$$	$\forall x, y \in \mathbb{N}, x + y \in \mathbb{N}$
\mathbb{Z} (Set of integers)	$\$\mathbb{Z}\$$	$\mathbb{N} \subseteq \mathbb{Z}$

\mathbb{Z}_+ (Set of positive integers)	\mathbb{Z}_+	$3 \in \mathbb{Z}_+$
\mathbb{Q} (Set of rational numbers)	\mathbb{Q}	$\sqrt{2} \notin \mathbb{Q}$
\mathbb{R} (Set of real numbers)	\mathbb{R}	$\forall x \in \mathbb{R} (x^2 \geq 0)$
\mathbb{R}_+ (Set of positive real numbers)	\mathbb{R}_+	$\forall x, y \in \mathbb{R}_+ (xy \in \mathbb{R}_+)$
\mathbb{C} (Set of complex numbers)	\mathbb{C}	$\exists z \in \mathbb{C} (z^2 + 1 = 0)$
\mathbb{Z}_n (Set of integer modulo n)	\mathbb{Z}_n	In the world of \mathbb{Z}_2 , $1 + 1 = 0$.
\mathbb{R}^3 (Three-dimensional Euclidean space)	\mathbb{R}^3	$(5, 1, 2) \in \mathbb{R}^3$

1.3 Key Mathematical Infinities

Symbols (Explanation)	LaTeX Code	Example
\aleph_0 (Cardinality of natural numbers)	\aleph_0	$\aleph_0 + 5 = \aleph_0$
\mathfrak{c} (Cardinality of real numbers)	\mathfrak{c}	$\mathfrak{c} = 2^{\aleph_0}$
ω (Smallest infinite ordinal number)	ω	$\forall n \in \mathbb{N} (n < \omega)$

1.4 Other Key Mathematical Objects

Symbols (Explanation)	LaTeX Code	Example
$\mathbf{0}$ (Zero vector)	<code>$\backslash\mathrm{0}$</code>	$\forall \mathbf{v} \in V, \mathbf{v} + \mathbf{0} = \mathbf{v}$
e (Identity element of a group)	<code>e</code>	$e \circ e = e$
I (Identity matrix)	<code>I</code>	$AI = IA = A$
C (Constant of integration)	<code>C</code>	$\int 1 \, dx = x + C$
\top (Tautology)	<code>\top</code>	For each proposition P , $P \wedge \top \equiv P$.
\perp (Contradiction)	<code>\bot</code>	For each proposition P , $P \wedge \neg P \equiv \perp$.
Z (Standard normal distribution)	<code>Z</code>	$Z \sim N(0, 1)$

2 Variables

2.1 Variables for Numbers

Symbols (Explanation)	LaTeX Code	Example
m, n, p, q (Integers and natural numbers)	<code>m</code> , <code>n</code> , <code>p</code> , <code>q</code>	$m + n - q = 1$

a, b, c (Coefficients for functions and equations)	$\$a$, \$b$, \$c$	$ax + by = 0$
x, y, z (Unknowns in functions and equations)	$\$x$, \$y$, \$z$	If $2x + 5 = 3$, then $x = -1$.
Δ (<u>Discriminant</u>)	Δ	$\Delta = b^2 - 4ac$ for <u>quadratic polynomials</u>
i, j, k (Index variables)	$\$i$, \$j$, \$k$	$\sum_{i=1}^{10} i = 55$
t (Time variable)	$\$t$	At $t = 5$, the velocity is $v(5) = 32$.
z (Complex numbers)	$\$z$	$z\bar{z} = z ^2$

2.2 Variables in Geometry

Symbols (Explanation)	LaTeX Code	Example
P, Q, R, S (<u>Vertices</u>)	$\$P$, \$Q$, \$R$, \$S$	$\overline{PQ} \perp \overline{QR}$
ℓ (Lines)	ℓ	$\ell_1 \parallel \ell_2$
$\alpha, \beta, \gamma, \theta$ (Angles)	α , β , γ , θ	$\alpha + \beta + \theta = 180^\circ$

2.3 Variables in Calculus

Symbols (Explanation)	LaTeX Code	Example
--------------------------	------------	---------

$f(x), g(x, y), h(z)$ (Functions)	$\$f(x)\$, \$g(x,y)\$, \$h(z)\$$	$f(2) = g(3, 1) + 5$
a_n, b_n, c_n (Sequences)	$\$a_n\$, \$b_n\$, \$c_n\$$	$a_n = \frac{3}{n+2}$
$h, \Delta x$ (Limiting variables in derivatives)	$\$h\$, \$\Delta x\$$	$\lim_{h \rightarrow 0} \frac{e^h - e^0}{h} = 1$
δ, ε (Small quantities in proofs involving limits)	$\$\delta\$, \$\varepsilon\$,\$\varvarepsilon\$, \$\varepsilon\$,$	For all $\varepsilon > 0$, there is a $\delta > 0$ such that $ x < \delta$ implies that $ 2x < \varepsilon$.
$F(x), G(x)$ (Antiderivatives)	$\$F(x)\$, \$G(x)\$$	$F'(x) = f(x)$

2.4 Variables in Linear Algebra

Symbols (Explanation)	LaTeX Code	Example
$\mathbf{u}, \mathbf{v}, \mathbf{w}$ (Vectors)	$\$\mathbf{u}\$, \$\mathbf{v}\$, \$\mathbf{w}\$$	$3\mathbf{u} + 4\mathbf{v} = \mathbf{w}$
A, B, C (Matrices)	$\$A\$, \$B\$, \$C\$$	$AX = B$
λ (Eigenvalues)	$\$\lambda\$$	$A\mathbf{v} = \lambda\mathbf{v}$

2.5 Variables in Set Theory and Logic

Symbols (Explanation)	LaTeX Code	Example
A, B, C (Sets)	$\$A\$, \$B\$, \$C\$$	$A \subseteq B \cup C$

a, b, c (Elements)	$\$a\$, \$b\$, \$c\%$	$a \in A$
P, Q, R (Propositions)	$\$P\$, \$Q\$, \$R\%$	$P \vee \neg P \equiv \top$

2.6 Variables in Probability and Statistics

Symbols (Explanation)	LaTeX Code	Example
X, Y, Z (Random variables)	$\$X\$, \$Y\$, \$Z\%$	$E(X + Y) = E(X) + E(Y)$
μ (Population means)	$\$\mu\%$	$H_0 : \mu = 5$
σ (Population standard deviations)	$\$\sigma\%$	$\sigma_1 = \sigma_2$
s (Sample standard deviations)	$\$s\%$	$s \neq \sigma$
n (Sample sizes)	$\$n\%$	For $n \geq 30$, use the normal distribution.
ρ (Population correlations)	$\$\rho\%$	$H_a : \rho < 0$
r (Sample correlations)	$\$r\%$	If $r = 0.75$, then $r^2 = 0.5625$.
π (Population proportions)	$\$\pi\%$	$\pi = 0.5$
p (Sample proportions)	$\$p\%$	$p = \frac{X}{n}$

3 Delimiters

3.1 Common Delimiters

Symbols (Explanation)	LaTeX Code	Example
.	\$. \$	25.9703
(Decimal separator)		
:	:\$ \$	1 : 4 : 9 = 3 : 12 : 27
(Ratio indicator)		
,	,\$ \$	(3, 5, 12)
(Object separator)		
(), [], { }	\$()\$, \$[]\$, \$\{ \}\$	$(a + b) \times c$
(Order-of-operation indicators)		
(), []	\$()\$, \$[]\$	$3 \notin (3, 4], 4 \in (3, 4]$
(Interval indicators)		

3.2 Other Delimiters

Symbols (Explanation)	LaTeX Code	Example
(), [], $\begin{pmatrix} x & y \end{pmatrix}$, $\begin{bmatrix} a \\ b \end{bmatrix}$	\$()\$, \$[]\$, \$\begin{pmatrix} x \\ y \end{pmatrix}\$ \$\begin{bmatrix} a \\ b \end{bmatrix}\$	$\begin{pmatrix} 1 & 4 \\ 3 & 6 \end{pmatrix}$
(Vector/matrix indicators)		
{ }	\$\{ \}\$	$\{\pi, e, i\}$
(Set builder)		
, :	\$\mid\$, :\$	$\{x \in \mathbb{R} \mid x^2 - 2 = 0\}$
("Such that" markers)		

$\ , $ (Metric-related operators)	$\$, \backslash \backslash \$$	$\ (3, 4)\ = 5$
$\begin{cases} f(x) & x \geq a \\ g(x) & x < a \end{cases}$ (Piecewise-function marker)	$\$ \backslash \text{begin}\{\text{cases}\} f(x) \& x \geq a \backslash \backslash g(x) \& x < a \backslash \text{end}\{\text{cases}\} \$$	$f(x) = \begin{cases} 1 & x \geq 0 \\ 0 & x < 0 \end{cases}$
$\langle \rangle$ (Inner product operator)	$\$ \backslash \text{langle} \backslash \text{rangle} \$$	$\langle ka, b \rangle = k \langle a, b \rangle$
$\lceil \rceil$ (Ceiling operator)	$\$ \backslash \text{lceil} \backslash \text{rceil} \$$	$\lceil 2.476 \rceil = 3$
$\lfloor \rfloor$ (Floor operator)	$\$ \backslash \text{lfloor} \backslash \text{rfloor} \$$	$\lfloor \pi \rfloor = 3$

4 Operators

4.1 Common Operators

Symbols (Explanation)	LaTeX Code	Example
$x + y$ (Sum)	$\$x+y\$$	$2a + 3a = 5a$
$x - y$ (Difference)	$\$x-y\$$	$11 - 5 = 6$
$-x$ (Additive inverse)	$\$-x\$$	$-3 + 3 = 0$
$x \times y, x \cdot y, xy$ (Product)	$\$x \backslash \text{times} y \$, \$x \backslash \text{cdot} y \$, \$xy \$$	$(m + 1)n = mn + n$
$x \div y, x/y$ (Quotient)	$\$x \backslash \text{div} y \$, \$x/y \$$	$152 \div 3 = 50.\overline{6}$

$\frac{x}{y}$ (Fraction)	$\displaystyle \frac{x}{y}$	$\frac{53+5}{6} = \frac{53}{6} + \frac{5}{6}$
x^y (Power)	x^y	$3^4 = 81$
$x \pm y$ (Plus and minus)	$x \pm y$	$\frac{-b \pm \sqrt{\Delta}}{2a}$
\sqrt{x} (Positive square root)	\sqrt{x}	$\sqrt{2} \approx 1.414$
$ x $ (Absolute value)	$ x $	$ x-3 < 5$
$x\%$ (Percent)	$x\%$	$x\% \doteq \frac{x}{100}$

4.2 Function-related Operators

Symbols (Explanation)	LaTeX Code	Example
$\operatorname{dom} f$ (Domain)	$\operatorname{dom} f$	If $g(x) = \ln x$, then $\operatorname{dom}(g) = \mathbb{R}$.
$\operatorname{ran} f$ (Range)	$\operatorname{ran} f$	If $h(y) = \sin y$, then $\operatorname{ran}(h) = [-1, 1]$.
$f(x)$ (Image of an element)	$f(x)$	$g(5) = g(4) + 3$
$f(X)$ (Image of a set)	$f(X)$	$f(A \cap B) \subseteq f(A) \cap f(B)$
$f \circ g$ (Composite function)	$f \circ g$	If $g(3) = 5$ and $f(5) = 8$, then $(f \circ g)(3) = 8$.

4.3 Elementary Functions

Symbols (Explanation)	LaTeX Code	Example
$k_n x^n + \cdots + k_0 x^0$ (Polynomial)	<code>\$k_n x^n + \cdots + k_0 x^0\$</code>	The polynomial $x^3 + 2x^2 + 3$ has a root in $(-3, -2)$.
e^x , $\exp x$ (Natural exponential function)	<code>\$e^x\$</code> , <code>\$\exp x\$</code>	$e^{x+y} = e^x \cdot e^y$
b^x (General exponential function)	<code>\$b^x\$</code>	$2^x > x^2$ for large x .
$\ln x$ (Natural logarithmic function)	<code>\$\ln x\$</code>	$\ln(x^2) = 2 \ln x$
$\log x$ (Common logarithmic function)	<code>\$\log x\$</code>	$\log 10000 = 4$
$\log_b x$ (General logarithmic function)	<code>\$\log_b x\$</code>	$\log_2 x = \frac{\ln x}{\ln 2}$
$\sin x$ (Sine function)	<code>\$\sin x\$</code>	$\sin \pi = 0$
$\cos x$ (Cosine function)	<code>\$\cos x\$</code>	$\cos \frac{\pi}{4} = \frac{\sqrt{2}}{2}$
$\tan x$ (Tangent function)	<code>\$\tan x\$</code>	$\tan x = \frac{\sin x}{\cos x}$

4.4 Algebra-related Operators

Symbols (Explanation)	LaTeX Code	Example
$\gcd(x, y)$ (Greatest common factor)	<code>\$\gcd (x,y)\$</code>	$\gcd(35, 14) = 7$

$\lfloor x \rfloor$ (Floor operator)	$\text{\texttt{\$}\texttt{\lfloor} x \texttt{\rfloor}\texttt{\$}}$	$\lfloor 3.6 \rfloor = 3$
$\lceil x \rceil$ (Ceiling operator)	$\text{\texttt{\$}\texttt{\lceil} x \texttt{\rceil}\texttt{\$}}$	$\lceil \pi \rceil = 4$
$\min(A)$ (Minimum)	$\text{\texttt{\$}\texttt{\min} (A)\texttt{\$}}$	If $\min(A) = 3$, then $\min(A + 5) = 8$.
$\max(A)$ (Maximum)	$\text{\texttt{\$}\texttt{\max} (A)\texttt{\$}}$	$\max(A \cup B) \geq \max(A)$
$x \bmod y$ (Modulo operator)	$\text{\texttt{\$}x\texttt{\bmod} y\texttt{\$}}$	$36 \bmod 5 = 1$
$\sum_{i=m}^n a_i$ (Summation)	$\text{\texttt{\$}\texttt{\displaystyle} \texttt{\sum}_{\texttt{\{i=m\}}^n a_{\texttt{i}}}\texttt{\$}}$	$\sum_{i=1}^5 i^2 = 55$
$\prod_{i=m}^n a_i$ (Pi Product)	$\text{\texttt{\$}\texttt{\displaystyle} \texttt{\prod}_{\texttt{\{i=m\}}^n a_{\texttt{i}}}\texttt{\$}}$	$\prod_{i=1}^n i = n!$
$[a]$ (Equivalence class)	$\text{\texttt{\$}[a]\texttt{\$}}$	$[a] \doteq \{x \mid xRa\}$
$\deg f$ (Degree of polynomial)	$\text{\texttt{\$}\texttt{\deg} f\texttt{\$}}$	$\deg(2x^2 + 3x + 5) = 2$
\bar{z} (Complex conjugate)	$\text{\texttt{\$}\texttt{\bar{\{z}\}}\texttt{\$}}$	$\overline{5 - 8i} = 5 + 8i$
$ z $ (Absolute value of complex number)	$\text{\texttt{\$} z \texttt{\$}}$	$ e^{\pi i} = 1$
$\arg z$ (Arguments of complex number)	$\text{\texttt{\$}\texttt{\arg} z\texttt{\$}}$	$\arg(1 + i) = \frac{\pi}{4} + 2\pi n$

4.5 Geometry-related Operators

Symbols (Explanation)	LaTeX Code	Example
--------------------------	------------	---------

$\angle ABC$ (Angle)	$\text{\textbackslash angle } ABC$	$\angle ABC = \angle CBA$
$\angle ABC, m\angle ABC$ (Measure of angle)	$\text{\textbackslash measuredangle } ABC$, $\text{\textbackslash m\textbackslash angle } ABC$	$\angle ABC = \angle A'B'C'$
\overleftrightarrow{AB} (Infinite line)	$\text{\textbackslash overlefttrightrightarrow } \{AB\}$	$\overleftrightarrow{AB} = \overleftrightarrow{BA}$
\overline{AB} (Line segment)	$\text{\textbackslash overline\{AB\}}$	If $B \neq B'$, then $\overline{AB} \neq \overline{AB'}$.
\overrightarrow{AB} (Ray)	$\text{\textbackslash overrightarrow\{AB\}}$	$\overrightarrow{AB} \cong \overrightarrow{CD}$
$ AB $ (Distance between two points)	$\text{\textbackslash AB }$	$ AB < A'B' $
$\triangle ABC$ (Triangle)	$\text{\textbackslash triangle } ABC$	$\triangle ABC \cong \triangle A'B'C'$
$\square ABCD$ (Quadrilateral)	$\text{\textbackslash square } ABCD$	$\square ABCD = \square DCBA$

4.6 Logic-related Operators

Symbols (Explanation)	LaTeX Code	Example
$\neg P$ (Negation)	$\text{\textbackslash not } P$	$\neg(1 = 2)$
$P \wedge Q$ (Conjunction)	$P \text{\textbackslash land } Q$	$P \wedge Q \equiv Q \wedge P$
$P \vee Q$ (Disjunction)	$P \text{\textbackslash lor } Q$	$\pi^e \in \mathbb{Q} \vee \pi^e \notin \mathbb{Q}$
$P \rightarrow Q$ (Conditional)	$P \text{\textbackslash to } Q$	$P \rightarrow Q \equiv (\neg P \vee Q)$
$P \leftrightarrow Q$ (Biconditional)	$P \text{\textbackslash leftrightarrow } Q$	$P \leftrightarrow Q \implies P \rightarrow Q$

$\forall x P(x)$ (Universal statement)	$\forall x P(x)$	$\forall y \in \mathbb{N} (y + 1 \in \mathbb{N})$
$\exists x P(x)$ (Existential statement)	$\exists x P(x)$	$\exists z (z^2 = -\pi)$

4.7 Set-related Operators

Symbols (Explanation)	LaTeX Code	Example
\overline{A}, A^c (Complement)	\overline{A} , A^c	$\overline{\overline{A}} = A$
$A \cap B$ (Intersection)	$A \cap B$	$\{2, 5\} \cap \{1, 3\} = \emptyset$
$A \cup B$ (Union)	$A \cup B$	$\mathbb{N} \cup \mathbb{Z} = \mathbb{Z}$
$A/B, A - B$ (Set difference)	A/B , $A - B$	In general, $A - B \neq B - A$.
$A \times B$ (Cartesian product)	$A \times B$	$(11, -35) \in \mathbb{N} \times \mathbb{Z}$
$\mathcal{P}(A)$ (Power set)	$\mathcal{P}(A)$	$\mathcal{P}(\emptyset) = \{\emptyset\}$
$ A $ (Cardinality)	$ A $	$ \mathbb{N} = \aleph_0$

4.8 Vector-related Operators

Symbols (Explanation)	LaTeX Code	Example
$\ \mathbf{v}\ $ (Norm of vector)	$\ \mathbf{v}\ $	$\ (3, 4)\ = 5$

$\mathbf{u} \cdot \mathbf{v}$ (Dot product)	$\text{\texttt{\$}\texttt{\textbackslash mathbf\{u\}} \texttt{\textbackslash cdot} \texttt{\textbackslash mathbf\{v\}}\texttt{\$}}$	$\mathbf{u} \cdot \mathbf{u} = \ \mathbf{u}\ ^2$
$\mathbf{u} \times \mathbf{v}$ (Cross product)	$\text{\texttt{\$}\texttt{\textbackslash mathbf\{u\}} \texttt{\textbackslash times} \texttt{\textbackslash mathbf\{v\}}\texttt{\$}}$	$\mathbf{u} \times \mathbf{u} = \mathbf{0}$
$\text{proj}_{\mathbf{v}} \mathbf{u}$ (Projection vector)	$\text{\texttt{\$}\texttt{\textbackslash operatorname\{proj\}} \texttt{\textbackslash_{\texttt{\textbackslash mathbf\{v\}}}} \texttt{\textbackslash mathbf\{u\}}\texttt{\$}}$	$\text{proj}_{(0,1)}(5, 4) = (0, 4)$
$\text{span}(S)$ (Span of vectors)	$\text{\texttt{\$}\texttt{\textbackslash operatorname\{span\}} \texttt{\textbackslash(S)}\texttt{\$}}$	$\text{span}(\{\mathbf{i}, \mathbf{j}\}) = \mathbb{R}^2$
$\dim(V)$ (Dimension of vector space)	$\text{\texttt{\$}\texttt{\textbackslash dim(V)}\texttt{\$}}$	$\dim(\mathbb{R}^3) = 3$

4.9 Matrix-related Operators

Symbols (Explanation)	LaTeX Code	Example
$A + B$ (Matrix sum)	$\text{\texttt{\$}A+B\texttt{\$}}$	$A + X = B$
$A - B$ (Matrix difference)	$\text{\texttt{\$}A-B\texttt{\$}}$	In general, $A - B \neq B - A$.
$-A$ (Additive inverse)	$\text{\texttt{\$}-A\texttt{\$}}$	$B + (-B) = 0$
kA (Scalar product)	$\text{\texttt{\$}kA\texttt{\$}}$	$(-1)A = -A$
AB (Matrix product)	$\text{\texttt{\$}AB\texttt{\$}}$	$AI = IA = A$
A^T (Matrix transpose)	$\text{\texttt{\$}A^T\texttt{\$}}$	$I^T = I$
A^{-1} (Matrix inverse)	$\text{\texttt{\$}A^{-1}\texttt{\$}}$	$(AB)^{-1} = B^{-1}A^{-1}$
$\text{tr}(A)$ (Trace of matrix)	$\text{\texttt{\$}\texttt{\textbackslash operatorname\{tr\}} \texttt{\textbackslash(A)}\texttt{\$}}$	$\text{tr}(A^T) = \text{tr}(A)$

$\det(A), A ,$	$\begin{vmatrix} x & y \\ w & z \end{vmatrix}$	$\det(A), A ,$	$\begin{vmatrix} 1 & 4 \\ 3 & 2 \end{vmatrix} = 2 - 12 = -10$
(Determinant)			

4.10 Probability-related Operators

Symbols (Explanation)	LaTeX Code	Example
$n!$ (Factorial)	$\$n!\$$	$4! = 4 \cdot 3 \cdot 2 \cdot 1$
nPr (Permutation)	$\$nPr\$$	$5P3 = 5 \cdot 4 \cdot 3$
$nCr, \binom{n}{r}$ (Combination)	$\$nCr$, \$ \displaystyle \binom{n}{r} \$\backslash binom\{n\}\{r\} \$$	$\binom{5}{2} = \binom{5}{3}$
$P(E)$ (Probability of event)	$\$P(E)\$$	$P(A \cup B \cup C) = 0.\bar{3}$
$P(A B)$ (Conditional probability)	$\$P(A B)\$$	$P(A B) = \frac{P(A \cap B)}{P(B)}$
$E(X)$ (Expected value of random variable)	$\$E(X)\$$	$E(X + Y) = E(X) + E(Y)$
$V(X)$ (Variance of random variable)	$\$V(X)\$$	$V(5X) = 25V(X)$

4.11 Statistics-related Operators

Symbols (Explanation)	LaTeX Code	Example
--------------------------	------------	---------

\overline{X} (Sample mean)	$\overline{\{X\}}$	$3\overline{X} = \overline{3X}$
s^2 (Sample variance)	s^2	$s^2 = \frac{\sum (X - \overline{X})^2}{n - 1}$
σ^2 (Population variance)	σ^2	$\sigma^2 = \frac{\sum (X - \mu)^2}{n}$

4.12 Key Probability Functions and Distributions

Symbols (Explanation)	LaTeX Code	Example
$\text{Bin}(n, p)$ (Binomial distribution)	$\operatorname{Bin}(n, p)$	If X stands for the number of heads in 10 coin tosses, then $X \sim \text{Bin}(10, 0.5)$.
$\text{Geo}(p)$ (Geometric distribution)	$\operatorname{Geo}(p)$	$Y \sim \text{Geo}(1/5)$, then $E(Y) = 5$.
$U(a, b)$ (Continuous uniform distribution)	$U(a, b)$	If $X \sim U(3, 7)$, then $V(X) = \frac{(7 - 3)^2}{12}$.
$N(\mu, \sigma^2)$ (Normal distribution)	$N(\mu, \sigma^2)$	If $X \sim N(3, 5^2)$, then $\frac{X - 3}{5} \sim Z$.
z_α (Critical z-score)	z_{α}	$z_{0.05} \approx 1.645$
$t_{\alpha, \nu}$ (Critical t-score)	$t_{\alpha, \nu}$	$t_{0.05, 1000} \approx z_{0.05}$
$\chi^2_{\alpha, \nu}$ (Critical Chi-squared-score)	$\chi^2_{\alpha, \nu}$	$\chi^2_{0.05, 30} \approx 43.77$

$$F_{\alpha, \nu_1, \nu_2} \quad \$F_{\{\alpha, \nu_1, \nu_2\}}\$ \quad F_{0.05, 20, 20} \approx 2.1242$$

(Critical F-score)

4.13 Calculus-related Operators

Symbols (Explanation)	LaTeX Code	Example
$\lim_{n \rightarrow \infty} a_n$ (Limit of sequence)	$\displaystyle \lim_{n \rightarrow \infty} a_n$	$\lim_{n \rightarrow \infty} \frac{n+3}{2n} = \frac{1}{2}$
$\lim_{x \rightarrow c} f(x)$ (Limit of function)	$\displaystyle \lim_{x \rightarrow c} f(x)$	$\lim_{x \rightarrow 3} \frac{\pi \sin x}{2} = \frac{\pi}{2} \lim_{x \rightarrow 3} \sin x$
$\sup(A)$ (Supremum)	$\sup(A)$	$\sup([-3, 5]) = 5$
$\inf(A)$ (Infimum)	$\inf(A)$	If $B = \left\{\frac{1}{1}, \frac{1}{2}, \dots\right\}$, then $\inf(B) = 0$.
$f', f'', f''', f^{(n)}$ (Derivative)	$f', f'', f''', f^{(n)}$	$(\sin x)''' = -\cos x$
$\int_a^b f(x) dx$ (Definite integral)	$\displaystyle \int_a^b f(x) dx$	$\int_0^1 \frac{1}{1+x^2} = \frac{\pi}{4}$
$\int f(x) dx$ (Indefinite integral)	$\displaystyle \int f(x) dx$	$\int \ln x dx = x \ln x - x$
f_x (Partial derivative)	f_x	If $f(x, y) = x^2 y^3$, then $f_x(x, y) = 2xy^3$.

5 Relational Symbols

5.1 Equality-based Relational Symbols

Symbols (Explanation)	LaTeX Code	Example
$x = y$ (Equal)	$\text{\$x = y\$}$	$3x - x = 2x$
$x \neq y$ (Non-equal)	$\text{\$x \neq y\$}$	$2 \neq 3$
$x \approx y$ (Approximately equal)	$\text{\$x \approx y\$}$	$\pi \approx 3.1416$
$x \sim y, xRy$ (Related to)	$\text{\$x \sim y\$}, \text{\$xRy\$}$	xRy if and only if $ x = y $
$x \equiv y$ (Equivalent to)	$\text{\$x \equiv y\$}$	$2 \equiv 101 \text{ in mod } 33$
$f(x) \propto g(x)$ (Proportional to)	$\text{\$f(x) \propto g(x)\$}$	$V \propto r^3$

5.2 Comparison-based Relational Symbols

Symbols (Explanation)	LaTeX Code	Example
$x < y$ (Less than)	$\text{\$x < y\$}$	$\sin x < 3$
$x > y$ (Greater than)	$\text{\$x > y\$}$	$\pi > e$
$x \leq y$ (Less than or equal to)	$\text{\$x \leq y\$}$	$n! \leq n^n$

$x \geq y$
(Greater than or
equal to)

$\$x \geq y\$$

$x^2 \geq 0$

5.3 Number-related Relational Symbols

Symbols (Explanation)	LaTeX Code	Example
$m \mid n$ (Divisibility)	$\$m \mid n\$$	$101 \mid 1111$
$m \perp n$ (Coprime integers)	$\$m \perp n\$$	$31 \perp 97$

5.4 Geometry-related Relational Symbols

Symbols (Explanation)	LaTeX Code	Example
$\ell_1 \parallel \ell_2$ (Parallel)	$\$\ell_1 \parallel \ell_2\$$	$\overline{PQ} \parallel \overline{RS}$
$\ell_1 \perp \ell_2$ (Perpendicular)	$\$\ell_1 \perp \ell_2\$$	$\overrightarrow{AB} \perp \overrightarrow{BC}$
$F \sim F'$ (Similar figures)	$\$F \sim F'\$$	$\triangle ABC \sim \triangle DEF$
$F \cong F'$ (Congruent figures)	$\$F \cong F'\$$	$\square ABCD \cong \square PQRS$

5.5 Set-related Relational Symbols

Symbols (Explanation)	LaTeX Code	Example
--------------------------	------------	---------

$a \in A$ (Member of)	$\$a \backslash \text{in } A\$$	$\frac{2}{3} \in \mathbb{R}$
$a \notin A$ (Not a member of)	$\$a \backslash \text{notin } A\$$	$\pi \notin \mathbb{Q}$
$A \subseteq B$ (Subset of)	$\$A \backslash \text{subsepeq } B\$$	$A \cap B \subseteq A$
$A = B$ (Equal Sets)	$\$A = B\$$	If $A = B$, then $A \subseteq B$.

5.6 Logic-related Relational Symbols

Symbols (Explanation)	LaTeX Code	Example
$P \implies Q$ (Implies)	$\$P \backslash \text{implies } Q\$$	x is even \implies 2 divides x
$P \impliedby Q$ (Implied by)	$\$P \backslash \text{impliedby } Q\$$	$x = 3 \impliedby 3x + 2 = 11$
$P \iff Q$, $P \equiv Q$ (If and only if)	$\$P \backslash \text{iff } Q\$$, $\$P \backslash \text{equiv } Q\$$	$x \neq y \iff$ $(x - y)^2 > 0$
$P \therefore Q$ (Therefore)	$\$P \backslash \text{therefore } Q\$$	$i \in \mathbb{C} \therefore \exists z (z \in \mathbb{C})$
$P \because Q$ (Because)	$\$P \backslash \text{because } Q\$$	$x = \frac{\pi}{2} \because$ $\sin x = 1$ and $\cos x = 0$

5.7 Probability-related Relational Symbols

Symbols (Explanation)	LaTeX Code	Example
$A \perp B$ (Independent events)	$\$A \backslash \text{perp } B\$$	If $A \perp B$, then $P(A \cap B) =$ $P(A) \cap P(B)$.

$X \sim F$
(X follows
distribution F)

$\$X \sim F\$$

$Y \sim \text{Bin}(30, 0.4)$

5.8 Calculus-related Relational Symbols

Symbols (Explanation)	LaTeX Code	Example
$f(x) \sim g(x)$ (Asymptotically equal)	$\$f(x) \sim g(x)\$$	$\pi(x) \sim \frac{x}{\ln x}$
$f(x) \in O(g(x))$ (In the big-O of)	$\$f(x) \in O(g(x))\$$	$2x^2 + 3x + 3 \in O(x^2)$

6 Notational Symbols

6.1 Common Notational Symbols

Symbols (Explanation)	LaTeX Code	Example
\dots, \cdots (Horizontal ellipsis)	$\$\ldots$, \$\cdots\$$	$1^2 + 2^2 + \cdots + n^2$
\vdots, \ddots (Vertical ellipsis)	$\$\vdots$, \$\ddots\$$	$\begin{pmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \cdots & a_{mn} \end{pmatrix}$
$f : A \rightarrow B,$ $A \xrightarrow{f} B$ (Function's domain/codomain specifier)	$\$f : A \rightarrow B$, \$A \xrightarrow{f} B\$$	A function $g : \mathbb{N} \rightarrow \mathbb{R}$ can be thought of as a sequence.

$x \mapsto f(x)$ (Function mapping rule)	$\$x \ \mapsto f(x)\$$	The function $x \mapsto x^2$ is increasing in the interval $[0, \infty)$.
$Q.E.D., \blacksquare, \square$ (End-of-the-proof symbols)	$\$Q. E. D.\$, \\\blacksquare\$, \\\square\$$	Thus the result is established as desired. \blacksquare
$Q.E.A., \perp$ (Contradiction symbols)	$\$Q. E. A.\$, \$\bot\$$	Multiplying both sides of the equation yields that $1 = 2$. \perp

6.2

Notational Symbols in Geometry and Trigonometry

Symbols (Explanation)	LaTeX Code	Example
$^\circ$ (Degree)	$\$^{\{\backslashcirc\}}\$$	$\cos(90^\circ) = 0$
$'$ (Arcminute)	$\$'\$$	$35' = \left(\frac{35}{60}\right)^\circ$
$''$ (Arcsecond)	$\$''\$$	$20'' = \left(\frac{20}{60}\right)'$
rad (Radian)	$\$\mathrm{rad}\$$	$\pi \text{ rad} = 180^\circ$
grad (Gradian)	$\$\mathrm{grad}\$$	$100 \text{ grad} = 90^\circ$

6.3

Notational Symbols in Calculus

Symbols (Explanation)	LaTeX Code	Example
$+\infty$ (Positive infinity)	$\$+\infty\$$	$\frac{n^2 + 1}{n} \rightarrow +\infty$

$-\infty$ (Negative infinity)	$\text{\textbackslash}\infty$	$\lim_{x \rightarrow -\infty} e^x = 0$
Δx (Change in variable)	$\text{\textbackslash}\Delta x$	$m = \frac{\Delta y}{\Delta x}$
dx (Differential)	$\text{\textbackslash}\mathrm{d} x$	$dy = f'(x) dx$
∂x (Partial differential)	$\text{\textbackslash}\partial x$	$\frac{\partial f}{\partial x} dx$
df (Total differential)	$\text{\textbackslash}\mathrm{d} f$	$dg(x, y) = \frac{\partial g}{\partial x} dx + \frac{\partial g}{\partial y} dy$

6.4 Notational Symbols in Probability and Statistics

Symbols (Explanation)	LaTeX Code	Example
$i.i.d.$ (Independent and identically distributed)	$i.i.d.$	Given n i.i.d. random variables X_1, \dots, X_n , $V(X_1 + \dots + X_n) = V(X_1) + \dots + V(X_n)$.
H_0 (Null hypothesis)	H_0	$H_0 : \mu = 23$
H_a (Alternative hypothesis)	H_a	$H_a : \sigma_1^2 \neq \sigma_2^2$

7 Additional Resources

- **Ultimate LaTeX Reference Guide:** A definitive reference guide on the LaTeX language, with the commands, environments and

packages most LaTeX users will ever need

- **Definitive Guide to Learning Higher Mathematics:** A standalone 10-principle framework for tackling higher mathematical learning, thinking and problem solving
- **10 Commandments of Higher Mathematical Learning:** An illustrated web guide on 10 scalable rules for learning higher mathematics
- **Definitive Glossary of Higher Mathematical Jargon:** A tour around higher mathematics in 100 terms



MATH VAULT