

# L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> Cheat Sheet

## Document classes

**book** Default is two-sided.  
**report** No `\part` divisions.  
**article** No `\part` or `\chapter` divisions.  
**letter** Letter (?).  
**slides** Large sans-serif font.

Used at the very beginning of a document:

`\documentclass{class}`. Use `\begin{document}` to start contents and `\end{document}` to end the document.

## Common documentclass options

**10pt/11pt/12pt** Font size.  
**letterpaper/a4paper** Paper size.  
**twocolumn** Use two columns.  
**twoside** Set margins for two-sided.  
**landscape** Landscape orientation. Must use `dvips -t landscape`.  
**draft** Double-space lines.  
Usage: `\documentclass[opt, opt]{class}`.

## Packages

**fullpage** Use 1 inch margins.  
**anysize** Set margins with `\marginwidth{l}{r}{t}{b}`.  
**multicol** Use *n* columns with `\begin{multicols}{n}`.  
**latexsym** Use L<sup>A</sup>T<sub>E</sub>X symbol font.  
Use before `\begin{document}`. Usage: `\usepackage{package}`

## Title

`\author{text}` Author of document.  
`\title{text}` Title of document.  
`\date{text}` Date.

These commands go before `\begin{document}`. The declaration `\maketitle` goes at the top of the document.

## Miscellaneous

`\pagestyle{empty}` Empty header, footer and no page numbers.

## Document structure

<code>\part{title}</code>	<code>\subsubsection{title}</code>
<code>\chapter{title}</code>	<code>\paragraph{title}</code>
<code>\section{title}</code>	<code>\subparagraph{title}</code>
<code>\subsection{title}</code>	

Section commands can be followed with an `*`, like

`\section*{title}`, to suppress heading numbers.

`\setcounter{secnumdepth}{x}` suppresses heading numbers of depth  $> x$ , where `chapter` has depth 0.

## Text environments

`\begin{comment}` Comment block (not printed).  
`\begin{quote}` Indented quotation block.  
`\begin{quotation}` Like `quote` with indented paragraphs.  
`\begin{verse}` Quotation block for verse.

## Lists

`\begin{enumerate}` Numbered list.  
`\begin{itemize}` Bulleted list.  
`\begin{description}` Description list.  
`\item text` Add an item.  
`\item[x] text` Use *x* instead of normal bullet or number. Required for descriptions.

## References

`\label{marker}` Set a marker for cross-reference, often of the form `\label{sec:item}`.  
`\ref{marker}` Give section/body number of marker.  
`\pageref{marker}` Give page number of marker.  
`\footnote{text}` Print footnote at bottom of page.

## Floating bodies

`\begin{table}[place]` Add numbered table.  
`\begin{figure}[place]` Add numbered figure.  
`\begin{equation}[place]` Add numbered equation.  
`\caption{text}` Caption for the body.

The *place* is a list valid placements for the body. `t`=top, `b`=bottom, `p`=separate page, `!`=place even if ugly. Captions and label markers should be within the environment.

## Text properties

### Font face

Command	Declaration	Effect
<code>\textrm{text}</code>	<code>\rm text</code>	Roman family
<code>\textsf{text}</code>	<code>\sf text</code>	Sans serif family
<code>\texttt{text}</code>	<code>\tt text</code>	Typewriter family
<code>\textmd{text}</code>	<code>\md text</code>	Medium series
<code>\textbf{text}</code>	<code>\bf text</code>	<b>Bold series</b>
<code>\textup{text}</code>	<code>\up text</code>	Upright shape
<code>\textit{text}</code>	<code>\it text</code>	<i>Italic shape</i>
<code>\textsl{text}</code>	<code>\sl text</code>	<i>Slanted shape</i>
<code>\textsc{text}</code>	<code>\sc text</code>	SMALL CAPS SHAPE
<code>\emph{text}</code>	<code>\em text</code>	<i>Emphasized</i>
<code>\textnormal{text}</code>	<code>\normalfont text</code>	Document font
<code>\underline{text}</code>		<u>Underline</u>

The command `(tttt)` form handles spacing better than the declaration `(ttt)` form.

### Font size

<code>\tiny</code>	tiny	<code>\Large</code>	Large
<code>\scriptsize</code>	scriptsize	<code>\LARGE</code>	LARGE
<code>\footnotesize</code>	footnotesize	<code>\huge</code>	huge
<code>\small</code>	small		
<code>\normalsize</code>	normalsize	<code>\Huge</code>	Huge
<code>\large</code>	large		

These are declarations and should be used in the form `\small ...` or without braces to affect the entire document.

## Verbatim text

`\begin{verbatim}` Verbatim environment.  
`\begin{verbatim*}` Spaces are shown as `␣`.  
`\verb!text!` Text between the delimiting characters (in this case `!`) is verbatim.

## Justification

Environment	Declaration
<code>\begin{center}</code>	<code>\centering</code>
<code>\begin{flushleft}</code>	<code>\raggedright</code>
<code>\begin{flushright}</code>	<code>\raggedleft</code>

## Miscellaneous

`\linespread{x}` changes the line spacing by the multiplier *x*.

## Text-mode symbols

### Symbols

<code>&amp;</code>	<code>\&amp;</code>	<code>-</code>	<code>\_</code>	<code>...</code>	<code>\ldots</code>	<code>•</code>	<code>\textbullet</code>
<code>\$</code>	<code>\\$</code>	<code>^</code>	<code>\^{}{}</code>	<code> </code>	<code>\textbar</code>	<code>\</code>	<code>\textbackslash</code>
<code>%</code>	<code>\%</code>	<code>~</code>	<code>\~{}{}</code>	<code>#</code>	<code>\#</code>	<code> </code>	<code>\textbar</code>

### Accents

<code>ò</code>	<code>\`o</code>	<code>ó</code>	<code>\'o</code>	<code>ô</code>	<code>\^o</code>	<code>õ</code>	<code>\~o</code>	<code>ö</code>	<code>\=o</code>
<code>ô</code>	<code>\.o</code>	<code>ö</code>	<code>\"o</code>	<code>q</code>	<code>\c o</code>	<code>õ</code>	<code>\v o</code>	<code>ő</code>	<code>\H o</code>
<code>ç</code>	<code>\c c</code>	<code>q</code>	<code>\d o</code>	<code>q</code>	<code>\b o</code>	<code>ö</code>	<code>\t oo</code>	<code>œ</code>	<code>\oe</code>
<code>Œ</code>	<code>\OE</code>	<code>æ</code>	<code>\ae</code>	<code>Æ</code>	<code>\AE</code>	<code>ä</code>	<code>\aa</code>	<code>Å</code>	<code>\AA</code>
<code>ø</code>	<code>\o</code>	<code>Ø</code>	<code>\O</code>	<code>l</code>	<code>\l</code>	<code>L</code>	<code>\L</code>	<code>ı</code>	<code>\i</code>
<code>j</code>	<code>\j</code>	<code>i</code>	<code>\i</code>	<code>ı</code>	<code>\i</code>				

### Delimiters

<code>'</code>	<code>\'</code>	<code>{</code>	<code>\{</code>	<code>[</code>	<code>\[</code>	<code>(</code>	<code>\(</code>	<code>&lt;</code>	<code>\textless</code>
<code>'</code>	<code>\'</code>	<code>}</code>	<code>\}</code>	<code>]</code>	<code>\]</code>	<code>)</code>	<code>\)</code>	<code>&gt;</code>	<code>\textgreater</code>

### Dashes

Name	Source	Example	Usage
hyphen	-	X-ray	In words.
en-dash	--	1–5	Between numbers.
em-dash	---	Yes—or no?	Punctuation.

### Line and page breaks

`\` Begin new line without new paragraph.  
`\*` Prohibit pagebreak after linebreak.  
`\kill` Don't print current line.  
`\pagebreak` Start new page.  
`\noindent` Do not indent current line.

### Miscellaneous

`\today` March 3, 2005.  
`\$sim$` Prints `~` instead of `\~{}{}`, which makes `~`.  
`~` Space, disallow linebreak (W.J.~Clinton).  
`\@.` Indicate that the `.` ends a sentence when following an uppercase letter.  
`\hspace{l}` Horizontal space of length *l* (Ex: *l* = 20pt).  
`\vspace{l}` Vertical space of length *l*.  
`\rule{w}{h}` Line of width *w* and height *h*.

# Tabular environments

## tabbing environment

\= Set tab stop.            \> Go to tab stop.  
Tab stops can be set on “invisible” lines with \kill at the end of the line. Normally \ is used to separate lines.

## tabular environment

\begin{array}[pos]{cols}  
\begin{tabular}[pos]{cols}  
\begin{tabular\*}{width}[pos]{cols}

## tabular column specification

l            Left-justified column.  
c            Centered column.  
r            Right-justified column.  
p{width}    Same as \parbox[t]{width}.  
@{decl}     Insert decl instead of inter-column space.  
|            Inserts a vertical line between columns.

## tabular elements

\hline       Horizontal line between rows.  
\cline{x-y}   Horizontal line across columns x through y.  
\multicolumn{n}{cols}{text}  
              A cell that spans n columns, with cols column specification.

# Math mode

To use math mode, surround text with \$ or use

\begin{equation}.  
~{x}            Superscript<sup>x</sup>        \_{x}            Subscript<sub>x</sub>  
\frac{x}{y}        $\frac{x}{y}$             \sum\_{k=1}^n        $\sum_{k=1}^n$   
\sqrt[n]{x}        $\sqrt[n]{x}$

## Math-mode symbols

$\leq$	\leq	$\geq$	\geq	$\neq$	\neq
$\cdot$	\cdot	$\times$	\times	$\div$	\div
$*$	\ast	$\circ$	\circ	$\cdots$	\cdots
$\alpha$	\alpha	$\beta$	\beta	$\gamma$	\gamma
$\delta$	\delta	$\epsilon$	\epsilon	$\varepsilon$	\varepsilon
$\zeta$	\zeta	$\eta$	\eta	$\theta$	\theta
$\vartheta$	\vartheta	$\iota$	\iota	$\kappa$	\kappa
$\lambda$	\lambda	$\mu$	\mu	$\nu$	\nu
$\xi$	\xi	$\pi$	\pi	$\rho$	\rho
$\sigma$	\sigma	$\tau$	\tau	$\upsilon$	\upsilon
$\phi$	\phi	$\chi$	\chi	$\psi$	\psi
$\omega$	\omega	$\Gamma$	\Gamma	$\Delta$	\Delta
$\Theta$	\Theta	$\Lambda$	\Lambda	$\Xi$	\Xi
$\Pi$	\Pi	$\Sigma$	\Sigma	$\Upsilon$	\Upsilon
$\Phi$	\Phi	$\Psi$	\Psi	$\Omega$	\Omega

## Special symbols

°    ~{\circ} Ex: 22°C: \$22~{\circ}\mathrm{C}\$.

# Bibliography and citations

When using BibTeX, you need to run latex, bibtex, and latex twice more to resolve dependencies.

## Citation types

\cite{key}            Full author list and year. (Watson and Crick 1953)  
\citeA{key}           Full author list. (Watson and Crick)  
\citeN{key}           Full author list and year. Watson and Crick (1953)  
\shortcite{key}       Abbreviated author list and year. ?  
\shortciteA{key}       Abbreviated author list. ?  
\shortciteN{key}       Abbreviated author list and year. ?  
\citeyear{key}        Cite year only. (1953)  
All the above have an NP variant without parentheses; Ex.  
\citeNP.

## BibTeX entry types

@article            Journal or magazine article.  
@book               Book with publisher.  
@booklet            Book without publisher.  
@conference        Article in conference proceedings.  
@inbook             A part of a book and/or range of pages.  
@incollection      A part of book with its own title.  
@manual             Technical documentation.  
@mastersthesis     Master’s thesis.  
@misc                If nothing else fits.  
@phdthesis          PhD. thesis.  
@proceedings       Proceedings of a conference.  
@techreport        Tech report, usually numbered in series.  
@unpublished        Unpublished.

## BibTeX fields

address            Address of publisher. Not necessary for major publishers.  
author              Names of authors, of format ....  
booktitle           Title of book when part of it is cited.  
chapter             Chapter or section number.  
edition              Edition of a book.  
editor               Names of editors.  
institution         Sponsoring institution of tech. report.  
journal              Journal name.  
key                  Used for cross ref. when no author.  
month                Month published. Use 3-letter abbreviation.  
note                 Any additional information.  
number               Number of journal or magazine.  
organization        Organization that sponsors a conference.  
pages                Page range (2,6,9--12).  
publisher            Publisher’s name.  
school               Name of school (for thesis).  
series                Name of series of books.  
title                 Title of work.  
type                 Type of tech. report, ex. “Research Note”.  
volume               Volume of a journal or book.  
year                 Year of publication.  
Not all fields need to be filled. See example below.

## Common BibTeX style files

abbrv	Standard	abstract	alpha with abstract
alpha	Standard	apa	APA
plain	Standard	unsrt	Unsorted

The L<sup>A</sup>T<sub>E</sub>X document should have the following two lines just before \end{document}, where bibfile.bib is the name of the BibTeX file.

```
\bibliographystyle{plain}  
\bibliography{bibfile}
```

## BibTeX example

The BibTeX database goes in a file called file.bib, which is processed with bibtex file.

```
@String{N = {Na\-ture}}  
@Article{WC:1953,  
  author  = {James Watson and Francis Crick},  
  title   = {A structure for Deoxyribose Nucleic Acid},  
  journal = N,  
  volume  = {171},  
  pages   = {737},  
  year    = 1953  
}
```

# Sample L<sup>A</sup>T<sub>E</sub>X document

```
\documentclass[11pt]{article}  
\usepackage{fullpage}  
\title{Template}  
\author{Name}  
\begin{document}  
\maketitle  
  
\section{section}  
\subsection*{subsection without number}  
text \textbf{bold text} text. Some math: $2+2=5$  
\subsection{subsection}  
text \emph{emphasized text} text. \cite{WC:1953}  
discovered the structure of DNA.
```

A table:  
\begin{table}[!th]  
\begin{tabular}{|l|c|r|}  
\hline  
first & row & data \\ second & row & data \\ \hline  
\end{tabular}  
\caption{This is the caption}  
\label{ex:table}  
\end{table}

The table is numbered \ref{ex:table}.  
\end{document}

# A quick guide to L<sup>A</sup>T<sub>E</sub>X

## What is L<sup>A</sup>T<sub>E</sub>X?

L<sup>A</sup>T<sub>E</sub>X (usually pronounced “LAY teck,” sometimes “LAH teck,” and never “LAY tex”) is a mathematics typesetting program that is the standard for most professional mathematics writing. It is based on the typesetting program T<sub>E</sub>X created by Donald Knuth of Stanford University (his first version appeared in 1978). Leslie Lamport was responsible for creating L<sup>A</sup>T<sub>E</sub>X a more user friendly version of T<sub>E</sub>X. A team of L<sup>A</sup>T<sub>E</sub>X programmers created the current version, L<sup>A</sup>T<sub>E</sub>X 2 $\epsilon$ .

## Math vs. text vs. functions

In properly typeset mathematics variables appear in italics (e.g.,  $f(x) = x^2 + 2x - 3$ ). The exception to this rule is predefined functions (e.g.,  $\sin(x)$ ). Thus it is important to **always** treat text, variables, and functions correctly. See the difference between  $x$  and  $x$ ,  $-1$  and  $-1$ , and  $\sin(x)$  and  $\sin(x)$ . There are two ways to present a mathematical expression—*inline* or as an *equation*.

## Inline mathematical expressions

Inline expressions occur in the middle of a sentence. To produce an inline expression, place the math expression between dollar signs (\$). For example, typing `$90^\circ$` is the same as `$\frac{\pi}{2}$ radians` yields  $90^\circ$  is the same as  $\frac{\pi}{2}$  radians.

## Equations

Equations are mathematical expressions that are given their own line and are centered on the page. These are usually used for important equations that deserve to be showcased on their own line or for large equations that cannot fit inline. To produce an inline expression, place the mathematical expression between the symbols \[ and \]. Typing `\[x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}\]` yields

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

## Displaystyle

To get full-sized inline mathematical expressions use `\displaystyle`. Use this sparingly. Typing `I want this $\displaystyle \sum_{n=1}^{\infty} \frac{1}{n}$, not this $\sum_{n=1}^{\infty} \frac{1}{n}$` yields

I want this  $\sum_{n=1}^{\infty} \frac{1}{n}$ , not this  $\sum_{n=1}^{\infty} \frac{1}{n}$ .

## Images

You can put images (pdf, png, jpg, or gif) in your document. They need to be in the same location as your .tex file when you compile the document. Omit `[width=.5in]` if you want the image to be full-sized.

```
\begin{figure}[ht]
\includegraphics[width=.5in]{imagename.jpg}
\caption{The (optional) caption goes here.}
\end{figure}
```

## Text decorations

Your text can be *italics* (`\textit{italics}`), **boldface** (`\textbf{boldface}`), or underlined (`\underline{underlined}`).

Your math can contain boldface, **R** (`\mathbf{R}`), or blackboard bold, **R** (`\mathbb{R}`). You may want to use these to express the sets of real numbers (**R** or **R**), integers (**Z** or **Z**), rational numbers (**Q** or **Q**), and natural numbers (**N** or **N**).

To have text appear in a math expression use `\text`.

`(0,1]=\{x\in\mathbb{R}:x>0\text{ and }x\leq 1\}` yields

$(0,1] = \{x \in \mathbb{R} : x > 0 \text{ and } x \leq 1\}$ . (Without the `\text` command it treats “and” as three variables:

$(0,1] = \{x \in \mathbb{R} : x > 0 \text{ and } x \leq 1\}$ .)

## Spaces and new lines

L<sup>A</sup>T<sub>E</sub>X ignores extra spaces and new lines. For example,

```
This sentence will look
fine after it is compiled.
```

This sentence will look fine after it is compiled.

Leave one full empty line between two paragraphs. Place `\` at the end of a line to create a new line (but not create a new paragraph).

```
This
compiles
```

```
like\
```

```
this.
```

This compiles

```
like
```

```
this.
```

Use `\noindent` to prevent a paragraph from indenting.

## Comments

Use `%` to create a comment. Nothing on the line after the `%` will be typeset. `$f(x)=\sin(x)$ %this is the sine function` yields  $f(x) = \sin(x)$

## Delimiters

description	command	output
parentheses	<code>(x)</code>	$(x)$
brackets	<code>[x]</code>	$[x]$
curly braces	<code>\{x\}</code>	$\{x\}$

To make your delimiters large enough to fit the content, use them together with `\right` and `\left`. For example, `\left\{\sin\left(\frac{1}{n}\right)\right\}_{n=1}^{\infty}` produces

$$\left\{\sin\left(\frac{1}{n}\right)\right\}_n^{\infty}.$$

Curly braces are non-printing characters that are used to gather text that has more than one character. Observe the differences between the four expressions `x^2`, `x^{2}`, `x^{2t}`, `x_{2t}` when typeset:  $x^2$ ,  $x^2$ ,  $x^{2t}$ ,  $x^{2t}$ .

## Lists

You can produce ordered and unordered lists.

description	command	output
	<code>\begin{itemize}</code> <code>\item</code> <code>Thing 1</code> <code>\item</code> <code>Thing 2</code> <code>\end{itemize}</code>	<ul style="list-style-type: none"><li>• Thing 1</li><li>• Thing 2</li></ul>
	<code>\begin{enumerate}</code> <code>\item</code> <code>Thing 1</code> <code>\item</code> <code>Thing 2</code> <code>\end{enumerate}</code>	<ol style="list-style-type: none"><li>1. Thing 1</li><li>2. Thing 2</li></ol>

## Symbols (in *math* mode)

### The basics

description	command	output
addition	<code>+</code>	$+$
subtraction	<code>-</code>	$-$
plus or minus	<code>\pm</code>	$\pm$
multiplication (times)	<code>\times</code>	$\times$
multiplication (dot)	<code>\cdot</code>	$\cdot$
division symbol	<code>\div</code>	$\div$
division (slash)	<code>/</code>	$/$
circle plus	<code>\oplus</code>	$\oplus$
circle times	<code>\otimes</code>	$\otimes$
equal	<code>=</code>	$=$
not equal	<code>\neq</code>	$\neq$
less than	<code>&lt;</code>	$<$
greater than	<code>&gt;</code>	$>$
less than or equal to	<code>\leq</code>	$\leq$
greater than or equal to	<code>\geq</code>	$\geq$
approximately equal to	<code>\approx</code>	$\approx$
infinity	<code>\infty</code>	$\infty$
dots	<code>1,2,3,\ldots</code>	$1, 2, 3, \dots$
dots	<code>1+2+3+\cdots</code>	$1 + 2 + 3 + \dots$
fraction	<code>\frac{a}{b}</code>	$\frac{a}{b}$
square root	<code>\sqrt{x}</code>	$\sqrt{x}$
<i>n</i> th root	<code>\sqrt[n]{x}</code>	$\sqrt[n]{x}$
exponentiation	<code>a^b</code>	$a^b$
subscript	<code>a_b</code>	$a_b$
absolute value	<code> x </code>	$ x $
natural log	<code>\ln(x)</code>	$\ln(x)$
logarithms	<code>\log_{a}b</code>	$\log_a b$
exponential function	<code>e^x=\exp(x)</code>	$e^x = \exp(x)$
degree	<code>\deg(f)</code>	$\deg(f)$

## Functions

description	command	output
maps to	<code>\to</code>	$\rightarrow$
composition	<code>\circ</code>	$\circ$
piecewise function	<code>\begin{cases} x &amp; x \geq 0 \\ -x &amp; x &lt; 0 \end{cases}</code>	$ x  = \begin{cases} x & x \geq 0 \\ -x & x < 0 \end{cases}$

## Greek and Hebrew letters

command	output	command	output
<code>\alpha</code>	$\alpha$	<code>\tau</code>	$\tau$
<code>\beta</code>	$\beta$	<code>\theta</code>	$\theta$
<code>\chi</code>	$\chi$	<code>\upsilon</code>	$\upsilon$
<code>\delta</code>	$\delta$	<code>\xi</code>	$\xi$
<code>\epsilon</code>	$\epsilon$	<code>\zeta</code>	$\zeta$
<code>\varepsilon</code>	$\varepsilon$	<code>\Delta</code>	$\Delta$
<code>\eta</code>	$\eta$	<code>\Gamma</code>	$\Gamma$
<code>\gamma</code>	$\gamma$	<code>\Lambda</code>	$\Lambda$
<code>\iota</code>	$\iota$	<code>\Omega</code>	$\Omega$
<code>\kappa</code>	$\kappa$	<code>\Phi</code>	$\Phi$
<code>\lambda</code>	$\lambda$	<code>\Pi</code>	$\Pi$
<code>\mu</code>	$\mu$	<code>\Psi</code>	$\Psi$
<code>\nu</code>	$\nu$	<code>\Sigma</code>	$\Sigma$
<code>\omega</code>	$\omega$	<code>\Theta</code>	$\Theta$
<code>\phi</code>	$\phi$	<code>\Upsilon</code>	$\Upsilon$
<code>\varphi</code>	$\varphi$	<code>\Xi</code>	$\Xi$
<code>\pi</code>	$\pi$	<code>\aleph</code>	$\aleph$
<code>\psi</code>	$\psi$	<code>\beth</code>	$\beth$
<code>\rho</code>	$\rho$	<code>\daleth</code>	$\daleth$
<code>\sigma</code>	$\sigma$	<code>\gimel</code>	$\gimel$

## Set theory

description	command	output
set brackets	<code>\{1,2,3\}</code>	$\{1,2,3\}$
element of	<code>\in</code>	$\in$
not an element of	<code>\notin</code>	$\notin$
subset of	<code>\subset</code>	$\subset$
subset of	<code>\subseteq</code>	$\subseteq$
not a subset of	<code>\not\subset</code>	$\not\subset$
contains	<code>\supset</code>	$\supset$
contains	<code>\supseteq</code>	$\supseteq$
union	<code>\cup</code>	$\cup$
intersection	<code>\cap</code>	$\cap$
big union	<code>\bigcup_{n=1}^{10} A_n</code>	$\bigcup_{n=1}^{10} A_n$
big intersection	<code>\bigcap_{n=1}^{10} A_n</code>	$\bigcap_{n=1}^{10} A_n$
empty set	<code>\emptyset</code>	$\emptyset$
power set	<code>\mathcal{P}</code>	$\mathcal{P}$
minimum	<code>\min</code>	$\min$
maximum	<code>\max</code>	$\max$
supremum	<code>\sup</code>	$\sup$
infimum	<code>\inf</code>	$\inf$
limit superior	<code>\limsup</code>	$\limsup$
limit inferior	<code>\liminf</code>	$\liminf$
closure	<code>\overline{A}</code>	$\overline{A}$

## Calculus

description	command	output
derivative	<code>\frac{df}{dx}</code>	$\frac{df}{dx}$
derivative	<code>\f'</code>	$f'$
partial derivative	<code>\frac{\partial f}{\partial x}</code>	$\frac{\partial f}{\partial x}$
integral	<code>\int</code>	$\int$
double integral	<code>\iint</code>	$\iint$
triple integral	<code>\iiint</code>	$\iiint$
limits	<code>\lim_{x \rightarrow \infty}</code>	$\lim_{x \rightarrow \infty}$
summation	<code>\sum_{n=1}^{\infty} a_n</code>	$\sum_{n=1}^{\infty} a_n$
product	<code>\prod_{n=1}^{\infty} a_n</code>	$\prod_{n=1}^{\infty} a_n$

## Logic

description	command	output
not	<code>\sim</code>	$\sim$
and	<code>\land</code>	$\wedge$
or	<code>\lor</code>	$\vee$
if...then	<code>\to</code>	$\rightarrow$
if and only if	<code>\leftrightarrow</code>	$\leftrightarrow$
logical equivalence	<code>\equiv</code>	$\equiv$
therefore	<code>\therefore</code>	$\therefore$
there exists	<code>\exists</code>	$\exists$
for all	<code>\forall</code>	$\forall$
implies	<code>\Rightarrow</code>	$\Rightarrow$
equivalent	<code>\Leftrightarrow</code>	$\Leftrightarrow$

## Linear algebra

description	command	output
vector	<code>\vec{v}</code>	$\vec{v}$
vector	<code>\mathbf{v}</code>	$\mathbf{v}$
norm	<code>  \vec{v}  </code>	$  \vec{v}  $
matrix	<code>\begin{bmatrix} 1 &amp; 2 &amp; 3 \\ 4 &amp; 5 &amp; 6 \\ 7 &amp; 8 &amp; 0 \end{bmatrix}</code>	$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 0 \end{bmatrix}$
determinant	<code>\begin{vmatrix} 1 &amp; 2 &amp; 3 \\ 4 &amp; 5 &amp; 6 \\ 7 &amp; 8 &amp; 0 \end{vmatrix}</code>	$\begin{vmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 0 \end{vmatrix}$
determinant	<code>\det(A)</code>	$\det(A)$
trace	<code>\operatorname{tr}(A)</code>	$\operatorname{tr}(A)$
dimension	<code>\dim(V)</code>	$\dim(V)$

## Number theory

description	command	output
divides	<code> </code>	$ $
does not divide	<code>\not </code>	$\nmid$
div	<code>\operatorname{div}</code>	$\operatorname{div}$
mod	<code>\mod</code>	$\operatorname{mod}$
greatest common divisor	<code>\gcd</code>	$\gcd$
ceiling	<code>\lceil x \rceil</code>	$\lceil x \rceil$
floor	<code>\lfloor x \rfloor</code>	$\lfloor x \rfloor$

## Geometry and trigonometry

description	command	output
angle	<code>\angle ABC</code>	$\angle ABC$
degree	<code>90^\circ</code>	$90^\circ$
triangle	<code>\triangle ABC</code>	$\triangle ABC$
segment	<code>\overline{AB}</code>	$\overline{AB}$
sine	<code>\sin</code>	$\sin$
cosine	<code>\cos</code>	$\cos$
tangent	<code>\tan</code>	$\tan$
cotangent	<code>\cot</code>	$\cot$
secant	<code>\sec</code>	$\sec$
cosecant	<code>\csc</code>	$\csc$
inverse sine	<code>\arcsin</code>	$\arcsin$
inverse cosine	<code>\arccos</code>	$\arccos$
inverse tangent	<code>\arctan</code>	$\arctan$

## Symbols (in *text* mode)

The followign symbols do **not** have to be surrounded by dollar signs.

description	command	output
dollar sign	<code>\\$</code>	$\$$
percent	<code>\%</code>	$\%$
ampersand	<code>\&amp;</code>	$\&$
pound	<code>\#</code>	$\#$
backslash	<code>\textbackslash</code>	$\backslash$
left quote marks	<code>‘ ‘</code>	$\text{‘ ‘}$
right quote marks	<code>’ ’</code>	$\text{’ ’}$
single left quote	<code>‘</code>	$\text{‘}$
single right quote	<code>’</code>	$\text{’}$
hyphen	<code>X-ray</code>	$\text{X-ray}$
en-dash	<code>pp. 5--15</code>	$\text{pp. 5--15}$
em-dash	<code>Yes---or no?</code>	$\text{Yes---or no?}$

## Resources

TUG: The  $\text{\TeX}$  Users Group  
 CTAN: The Comprehensive  $\text{\TeX}$  Archive Network  
 Handwriting-to- $\text{\LaTeX}$  sites: [Detexify](#), [WebEquation](#)  
 The Comprehensive  $\text{\LaTeX}$  Symbol List  
 The Not So Short Introduction to  $\text{\LaTeX}$  2 $\epsilon$   
 Software that generates  $\text{\LaTeX}$  code: Mathematica, Maple, GeoGebra  
 $\text{\LaTeX}$  for the Mac: [Mac \$\text{\TeX}\$](#)   
 $\text{\LaTeX}$  for the PC:  [\$\text{\TeX}\$ nicCenter](#) and [MiK \$\text{\TeX}\$](#)   
 $\text{\LaTeX}$  online: [Share \$\text{\LaTeX}\$](#) , [Overleaf](#), [Sage](#)  
 $\text{\LaTeX}$  integration with Microsoft Office, Apple iWork, etc:  
[MathType](#),  [\$\text{\LaTeX}\$ iT](#)

Dave Richeson, Dickinson College, <http://divisbyzero.com/>

# L<sup>A</sup>T<sub>E</sub>X Mathematical Symbols

The more unusual symbols are not defined in base L<sup>A</sup>T<sub>E</sub>X (NFSS) and require `\usepackage{amssymb}`

## 1 Greek and Hebrew letters

$\alpha$	<code>\alpha</code>	$\kappa$	<code>\kappa</code>	$\psi$	<code>\psi</code>	$F$	<code>\digamma</code>	$\Delta$	<code>\Delta</code>	$\Theta$	<code>\Theta</code>
$\beta$	<code>\beta</code>	$\lambda$	<code>\lambda</code>	$\rho$	<code>\rho</code>	$\varepsilon$	<code>\varepsilon</code>	$\Gamma$	<code>\Gamma</code>	$\Upsilon$	<code>\Upsilon</code>
$\chi$	<code>\chi</code>	$\mu$	<code>\mu</code>	$\sigma$	<code>\sigma</code>	$\varkappa$	<code>\varkappa</code>	$\Lambda$	<code>\Lambda</code>	$\Xi$	<code>\Xi</code>
$\delta$	<code>\delta</code>	$\nu$	<code>\nu</code>	$\tau$	<code>\tau</code>	$\varphi$	<code>\varphi</code>	$\Omega$	<code>\Omega</code>		
$\epsilon$	<code>\epsilon</code>	$o$	<code>o</code>	$\theta$	<code>\theta</code>	$\varpi$	<code>\varpi</code>	$\Phi$	<code>\Phi</code>	$\aleph$	<code>\aleph</code>
$\eta$	<code>\eta</code>	$\omega$	<code>\omega</code>	$\upsilon$	<code>\upsilon</code>	$\varrho$	<code>\varrho</code>	$\Pi$	<code>\Pi</code>	$\beth$	<code>\beth</code>
$\gamma$	<code>\gamma</code>	$\phi$	<code>\phi</code>	$\xi$	<code>\xi</code>	$\varsigma$	<code>\varsigma</code>	$\Psi$	<code>\Psi</code>	$\daleth$	<code>\daleth</code>
$\iota$	<code>\iota</code>	$\pi$	<code>\pi</code>	$\zeta$	<code>\zeta</code>	$\vartheta$	<code>\vartheta</code>	$\Sigma$	<code>\Sigma</code>	$\gimel$	<code>\gimel</code>

## 2 L<sup>A</sup>T<sub>E</sub>X math constructs

$\frac{abc}{xyz}$	<code>\frac{abc}{xyz}</code>	$\overline{abc}$	<code>\overline{abc}</code>	$\overrightarrow{abc}$	<code>\overrightarrow{abc}</code>
$f'$	<code>f'</code>	$\underline{abc}$	<code>\underline{abc}</code>	$\overleftarrow{abc}$	<code>\overleftarrow{abc}</code>
$\sqrt{abc}$	<code>\sqrt{abc}</code>	$\widehat{abc}$	<code>\widehat{abc}</code>	$\overbrace{abc}$	<code>\overbrace{abc}</code>
$\sqrt[n]{abc}$	<code>\sqrt[n]{abc}</code>	$\widetilde{abc}$	<code>\widetilde{abc}</code>	$\underbrace{abc}$	<code>\underbrace{abc}</code>

## 3 Delimiters

		{	\{		\lfloor	/	/	↑	\Uparrow	┐	\llcorner
	\vert	}	\}		\rfloor	\	\backslash	↑	\uparrow	┐	\lrcorner
	\	<	\langle		\lceil	[	[	↓	\Downarrow	└	\ulcorner
	\Vert	>	\rangle		\rceil	]	]	↓	\downarrow	└	\urcorner

Use the pair `\lefts1` and `\rights2` to match height of delimiters  $s_1$  and  $s_2$  to the height of their contents, e.g.,  
`\left| expr \right|`      `\left\{ expr \right\}`      `\left\Vert expr \right\Vert`.

## 4 Variable-sized symbols (displayed formulae show larger version)

$\sum$	<code>\sum</code>	$\int$	<code>\int</code>	$\biguplus$	<code>\biguplus</code>	$\bigoplus$	<code>\bigoplus</code>	$\bigvee$	<code>\bigvee</code>
$\prod$	<code>\prod</code>	$\oint$	<code>\oint</code>	$\bigcap$	<code>\bigcap</code>	$\bigotimes$	<code>\bigotimes</code>	$\bigwedge$	<code>\bigwedge</code>
$\coprod$	<code>\coprod</code>	$\iint$	<code>\iint</code>	$\bigcup$	<code>\bigcup</code>	$\bigodot$	<code>\bigodot</code>	$\bigsqcup$	<code>\bigsqcup</code>

## 5 Standard Function Names

Function names should appear in Roman, not Italic, e.g.,

Correct: `\tan(at-n\pi)`  $\longrightarrow \tan(at - n\pi)$   
 Incorrect: `\tan(at-n\pi)`  $\longrightarrow \tan(at - n\pi)$

$\arccos$	<code>\arccos</code>	$\arcsin$	<code>\arcsin</code>	$\arctan$	<code>\arctan</code>	$\arg$	<code>\arg</code>
$\cos$	<code>\cos</code>	$\cosh$	<code>\cosh</code>	$\cot$	<code>\cot</code>	$\coth$	<code>\coth</code>
$\csc$	<code>\csc</code>	$\deg$	<code>\deg</code>	$\det$	<code>\det</code>	$\dim$	<code>\dim</code>
$\exp$	<code>\exp</code>	$\gcd$	<code>\gcd</code>	$\hom$	<code>\hom</code>	$\inf$	<code>\inf</code>
$\ker$	<code>\ker</code>	$\lg$	<code>\lg</code>	$\lim$	<code>\lim</code>	$\liminf$	<code>\liminf</code>
$\limsup$	<code>\limsup</code>	$\ln$	<code>\ln</code>	$\log$	<code>\log</code>	$\max$	<code>\max</code>
$\min$	<code>\min</code>	$\Pr$	<code>\Pr</code>	$\sec$	<code>\sec</code>	$\sin$	<code>\sin</code>
$\sinh$	<code>\sinh</code>	$\sup$	<code>\sup</code>	$\tan$	<code>\tan</code>	$\tanh$	<code>\tanh</code>

## 6 Binary Operation/Relation Symbols

$*$	<code>\ast</code>	$\pm$	<code>\pm</code>	$\cap$	<code>\cap</code>	$\triangleleft$	<code>\lhd</code>
$\star$	<code>\star</code>	$\mp$	<code>\mp</code>	$\cup$	<code>\cup</code>	$\triangleright$	<code>\rhd</code>
$\cdot$	<code>\cdot</code>	$\amalg$	<code>\amalg</code>	$\oplus$	<code>\oplus</code>	$\triangleleft$	<code>\triangleleft</code>
$\circ$	<code>\circ</code>	$\odot$	<code>\odot</code>	$\sqcap$	<code>\sqcap</code>	$\triangleright$	<code>\triangleright</code>
$\bullet$	<code>\bullet</code>	$\ominus$	<code>\ominus</code>	$\sqcup$	<code>\sqcup</code>	$\triangleleft$	<code>\triangleleft</code>
$\bigcirc$	<code>\bigcirc</code>	$\oplus$	<code>\oplus</code>	$\wedge$	<code>\wedge</code>	$\triangleleft$	<code>\triangleleft</code>
$\diamond$	<code>\diamond</code>	$\oslash$	<code>\oslash</code>	$\vee$	<code>\vee</code>	$\nabla$	<code>\bigtriangledown</code>
$\times$	<code>\times</code>	$\otimes$	<code>\otimes</code>	$\dagger$	<code>\dagger</code>	$\triangle$	<code>\bigtriangleup</code>
$\div$	<code>\div</code>	$\wr$	<code>\wr</code>	$\ddagger$	<code>\ddagger</code>	$\setminus$	<code>\setminus</code>
$\cdot$	<code>\centerdot</code>	$\Box$	<code>\Box</code>	$\bar{\wedge}$	<code>\barwedge</code>	$\veebar$	<code>\veebar</code>
$\circledast$	<code>\circledast</code>	$\boxplus$	<code>\boxplus</code>	$\curlywedge$	<code>\curlywedge</code>	$\curlyvee$	<code>\curlyvee</code>
$\circledcirc$	<code>\circledcirc</code>	$\boxminus$	<code>\boxminus</code>	$\Cap$	<code>\Cap</code>	$\Cup$	<code>\Cup</code>
$\circledR$	<code>\circledR</code>	$\boxtimes$	<code>\boxtimes</code>	$\bot$	<code>\bot</code>	$\top$	<code>\top</code>
$\dot{+}$	<code>\dotplus</code>	$\boxdot$	<code>\boxdot</code>	$\intercal$	<code>\intercal</code>	$\times$	<code>\rightthreetimes</code>
$\div$	<code>\divideontimes</code>	$\square$	<code>\square</code>	$\bar{\wedge}$	<code>\doublebarwedge</code>	$\times$	<code>\leftthreetimes</code>
$\equiv$	<code>\equiv</code>	$\leq$	<code>\leq</code>	$\geq$	<code>\geq</code>	$\perp$	<code>\perp</code>
$\cong$	<code>\cong</code>	$\prec$	<code>\prec</code>	$\succ$	<code>\succ</code>	$\mid$	<code>\mid</code>
$\neq$	<code>\neq</code>	$\preceq$	<code>\preceq</code>	$\succeq$	<code>\succeq</code>	$\parallel$	<code>\parallel</code>
$\sim$	<code>\sim</code>	$\ll$	<code>\ll</code>	$\gg$	<code>\gg</code>	$\bowtie$	<code>\bowtie</code>
$\simeq$	<code>\simeq</code>	$\subset$	<code>\subset</code>	$\supset$	<code>\supset</code>	$\Join$	<code>\Join</code>
$\approx$	<code>\approx</code>	$\subseteq$	<code>\subseteq</code>	$\supseteq$	<code>\supseteq</code>	$\ltimes$	<code>\ltimes</code>
$\asymp$	<code>\asymp</code>	$\sqsubset$	<code>\sqsubset</code>	$\sqsupset$	<code>\sqsupset</code>	$\rtimes$	<code>\rtimes</code>
$\doteq$	<code>\doteq</code>	$\sqsubseteq$	<code>\sqsubseteq</code>	$\sqsupseteq$	<code>\sqsupseteq</code>	$\smile$	<code>\smile</code>
$\propto$	<code>\propto</code>	$\dashv$	<code>\dashv</code>	$\vdash$	<code>\vdash</code>	$\frown$	<code>\frown</code>
$\models$	<code>\models</code>	$\in$	<code>\in</code>	$\ni$	<code>\ni</code>	$\notin$	<code>\notin</code>
$\approx$	<code>\approxeq</code>	$\leq$	<code>\leq</code>	$\geq$	<code>\geq</code>	$\lessgtr$	<code>\lessgtr</code>
$\thicksim$	<code>\thicksim</code>	$\leq$	<code>\leq</code>	$\geq$	<code>\geq</code>	$\lesseqgtr$	<code>\lesseqgtr</code>
$\backsimeq$	<code>\backsimeq</code>	$\lessapprox$	<code>\lessapprox</code>	$\gtrapprox$	<code>\gtrapprox</code>	$\lesseqqgtr$	<code>\lesseqqgtr</code>
$\backsim$	<code>\backsim</code>	$\lll$	<code>\lll</code>	$\ggg$	<code>\ggg</code>	$\gtreqless$	<code>\gtreqless</code>
$\trianglelefteq$	<code>\trianglelefteq</code>	$\lessdot$	<code>\lessdot</code>	$\gtrdot$	<code>\gtrdot</code>	$\gtreqless$	<code>\gtreqless</code>
$\circeq$	<code>\circeq</code>	$\lesssim$	<code>\lesssim</code>	$\gtrsim$	<code>\gtrsim</code>	$\gtrless$	<code>\gtrless</code>
$\bumpeq$	<code>\bumpeq</code>	$\eqslantless$	<code>\eqslantless</code>	$\eqslantgtr$	<code>\eqslantgtr</code>	$\backepsilon$	<code>\backepsilon</code>
$\Bumpeq$	<code>\Bumpeq</code>	$\prec$	<code>\prec</code>	$\succ$	<code>\succ</code>	$\between$	<code>\between</code>
$\doteqdot$	<code>\doteqdot</code>	$\prec$	<code>\prec</code>	$\succ$	<code>\succ</code>	$\pitchfork$	<code>\pitchfork</code>
$\thickapprox$	<code>\thickapprox</code>	$\Subset$	<code>\Subset</code>	$\Supset$	<code>\Supset</code>	$\shortmid$	<code>\shortmid</code>
$\fallingdotseq$	<code>\fallingdotseq</code>	$\subseteq$	<code>\subseteq</code>	$\supseteq$	<code>\supseteq</code>	$\smallfrown$	<code>\smallfrown</code>
$\risingdotseq$	<code>\risingdotseq</code>	$\sqsubset$	<code>\sqsubset</code>	$\sqsupset$	<code>\sqsupset</code>	$\smallsmile$	<code>\smallsmile</code>
$\varpropto$	<code>\varpropto</code>	$\prec$	<code>\prec</code>	$\succ$	<code>\succ</code>	$\Vdash$	<code>\Vdash</code>
$\therefore$	<code>\therefore</code>	$\curlyeqprec$	<code>\curlyeqprec</code>	$\curlyeqsucc$	<code>\curlyeqsucc</code>	$\Vdash$	<code>\Vdash</code>
$\because$	<code>\because</code>	$\blacktriangleleft$	<code>\blacktriangleleft</code>	$\blacktriangleright$	<code>\blacktriangleright</code>	$\Vdash$	<code>\Vdash</code>
$\eqcirc$	<code>\eqcirc</code>	$\trianglelefteq$	<code>\trianglelefteq</code>	$\trianglerighteq$	<code>\trianglerighteq</code>	$\parallel$	<code>\parallel</code>
$\neq$	<code>\neq</code>	$\vartriangleleft$	<code>\vartriangleleft</code>	$\vartriangleright$	<code>\vartriangleright</code>	$\nshortparallel$	<code>\nshortparallel</code>
$\ncong$	<code>\ncong</code>	$\nleq$	<code>\nleq</code>	$\ngeq$	<code>\ngeq</code>	$\nsubseteq$	<code>\nsubseteq</code>
$\nmid$	<code>\nmid</code>	$\nleqq$	<code>\nleqq</code>	$\ngeqq$	<code>\ngeqq</code>	$\nsupseteq$	<code>\nsupseteq</code>
$\nparallel$	<code>\nparallel</code>	$\nleqslant$	<code>\nleqslant</code>	$\ngeqslant$	<code>\ngeqslant</code>	$\nsubseteqq$	<code>\nsubseteqq</code>
$\nshortmid$	<code>\nshortmid</code>	$\nless$	<code>\nless</code>	$\ngtr$	<code>\ngtr</code>	$\nsupseteqq$	<code>\nsupseteqq</code>
$\nshortparallel$	<code>\nshortparallel</code>	$\nprec$	<code>\nprec</code>	$\nsucc$	<code>\nsucc</code>	$\subsetneq$	<code>\subsetneq</code>
$\nsim$	<code>\nsim</code>	$\npreceq$	<code>\npreceq</code>	$\nsucceq$	<code>\nsucceq</code>	$\supsetneq$	<code>\supsetneq</code>
$\nVDash$	<code>\nVDash</code>	$\prec$	<code>\prec</code>	$\succ$	<code>\succ</code>	$\subsetneqq$	<code>\subsetneqq</code>
$\nvDash$	<code>\nvDash</code>	$\prec$	<code>\prec</code>	$\succ$	<code>\succ</code>	$\supsetneqq$	<code>\supsetneqq</code>
$\nvDash$	<code>\nvDash</code>	$\napprox$	<code>\napprox</code>	$\gtrapprox$	<code>\gtrapprox</code>	$\varsubsetneq$	<code>\varsubsetneq</code>
$\ntriangleleft$	<code>\ntriangleleft</code>	$\nleq$	<code>\nleq</code>	$\gneq$	<code>\gneq</code>	$\varsubsetneqq$	<code>\varsubsetneqq</code>
$\ntrianglelefteq$	<code>\ntrianglelefteq</code>	$\nleqq$	<code>\nleqq</code>	$\gneqq$	<code>\gneqq</code>	$\varsubsetneqq$	<code>\varsubsetneqq</code>
$\ntriangleright$	<code>\ntriangleright</code>	$\nsim$	<code>\nsim</code>	$\gnsim$	<code>\gnsim</code>	$\varsupsetneq$	<code>\varsupsetneq</code>
$\ntrianglerighteq$	<code>\ntrianglerighteq</code>	$\nvertneqq$	<code>\nvertneqq</code>	$\gvertneqq$	<code>\gvertneqq</code>	$\varsupsetneqq$	<code>\varsupsetneqq</code>

## 7 Arrow symbols

$\leftarrow$	<code>\leftarrow</code>	$\longleftarrow$	<code>\longleftarrow</code>	$\uparrow$	<code>\uparrow</code>
$\Leftarrow$	<code>\Leftarrow</code>	$\Lleftarrow$	<code>\Lleftarrow</code>	$\Uparrow$	<code>\Uparrow</code>
$\rightarrow$	<code>\rightarrow</code>	$\longrightarrow$	<code>\longrightarrow</code>	$\downarrow$	<code>\downarrow</code>
$\Rightarrow$	<code>\Rightarrow</code>	$\Longrightarrow$	<code>\Longrightarrow</code>	$\Downarrow$	<code>\Downarrow</code>
$\leftrightarrow$	<code>\leftrightarrow</code>	$\longleftrightarrow$	<code>\longleftrightarrow</code>	$\updownarrow$	<code>\updownarrow</code>
$\Leftrightarrow$	<code>\Leftrightarrow</code>	$\Longleftrightarrow$	<code>\Longleftrightarrow</code>	$\Updownarrow$	<code>\Updownarrow</code>
$\mapsto$	<code>\mapsto</code>	$\longmapsto$	<code>\longmapsto</code>	$\nearrow$	<code>\nearrow</code>
$\hookleftarrow$	<code>\hookleftarrow</code>	$\hookrightarrow$	<code>\hookrightarrow</code>	$\searrow$	<code>\searrow</code>
$\leftharpoonup$	<code>\leftharpoonup</code>	$\rightharpoonup$	<code>\rightharpoonup</code>	$\swarrow$	<code>\swarrow</code>
$\leftharpoondown$	<code>\leftharpoondown</code>	$\rightharpoondown$	<code>\rightharpoondown</code>	$\nwarrow$	<code>\nwarrow</code>
$\rightleftharpoons$	<code>\rightleftharpoons</code>	$\leadsto$	<code>\leadsto</code>		
$\dashrightarrow$	<code>\dashrightarrow</code>	$\dashleftarrow$	<code>\dashleftarrow</code>	$\leftrightsquigarrow$	<code>\leftrightsquigarrow</code>
$\leftrightsquigarrow$	<code>\leftrightsquigarrow</code>	$\Lleftarrow$	<code>\Lleftarrow</code>	$\twoheadleftarrow$	<code>\twoheadleftarrow</code>
$\leftarrowtail$	<code>\leftarrowtail</code>	$\looparrowleft$	<code>\looparrowleft</code>	$\leftrightharpoons$	<code>\leftrightharpoons</code>
$\curvearrowleft$	<code>\curvearrowleft</code>	$\circlearrowleft$	<code>\circlearrowleft</code>	$\Lsh$	<code>\Lsh</code>
$\Uparrow$	<code>\Uparrow</code>	$\upharpoonleft$	<code>\upharpoonleft</code>	$\downharpoonleft$	<code>\downharpoonleft</code>
$\multimap$	<code>\multimap</code>	$\leftrightsquigarrow$	<code>\leftrightsquigarrow</code>	$\Rightarrow$	<code>\Rightarrow</code>
$\rightleftarrows$	<code>\rightleftarrows</code>	$\Rightarrow$	<code>\Rightarrow</code>	$\rightleftarrows$	<code>\rightleftarrows</code>
$\twoheadrightarrow$	<code>\twoheadrightarrow</code>	$\rightarrowtail$	<code>\rightarrowtail</code>	$\looparrowright$	<code>\looparrowright</code>
$\rightleftharpoons$	<code>\rightleftharpoons</code>	$\curvearrowright$	<code>\curvearrowright</code>	$\circlearrowright$	<code>\circlearrowright</code>
$\Rsh$	<code>\Rsh</code>	$\downdownarrows$	<code>\downdownarrows</code>	$\upharpoonright$	<code>\upharpoonright</code>
$\downharpoonright$	<code>\downharpoonright</code>	$\rightsquigarrow$	<code>\rightsquigarrow</code>		
$\nleftarrow$	<code>\nleftarrow</code>	$\nrightarrow$	<code>\nrightarrow</code>	$\nLeftarrow$	<code>\nLeftarrow</code>
$\nrightarrow$	<code>\nrightarrow</code>	$\nleftrightarrow$	<code>\nleftrightarrow</code>	$\nLeftrightarrow$	<code>\nLeftrightarrow</code>

## 8 Miscellaneous symbols

$\infty$	<code>\infty</code>	$\forall$	<code>\forall</code>	$\Bbbk$	<code>\Bbbk</code>	$\wp$	<code>\wp</code>
$\nabla$	<code>\nabla</code>	$\exists$	<code>\exists</code>	$\bigstar$	<code>\bigstar</code>	$\angle$	<code>\angle</code>
$\partial$	<code>\partial</code>	$\nexists$	<code>\nexists</code>	$\diagdown$	<code>\diagdown</code>	$\measuredangle$	<code>\measuredangle</code>
$\eth$	<code>\eth</code>	$\emptyset$	<code>\emptyset</code>	$\diagup$	<code>\diagup</code>	$\sphericalangle$	<code>\sphericalangle</code>
$\clubsuit$	<code>\clubsuit</code>	$\varnothing$	<code>\varnothing</code>	$\Diamond$	<code>\Diamond</code>	$\complement$	<code>\complement</code>
$\diamondsuit$	<code>\diamondsuit</code>	$\imath$	<code>\imath</code>	$\Finv$	<code>\Finv</code>	$\triangledown$	<code>\triangledown</code>
$\heartsuit$	<code>\heartsuit</code>	$\jmath$	<code>\jmath</code>	$\Game$	<code>\Game</code>	$\triangle$	<code>\triangle</code>
$\spadesuit$	<code>\spadesuit</code>	$\ell$	<code>\ell</code>	$\hbar$	<code>\hbar</code>	$\vartriangle$	<code>\vartriangle</code>
$\cdots$	<code>\cdots</code>	$\iiint$	<code>\iiint</code>	$\hslash$	<code>\hslash</code>	$\blacklozenge$	<code>\blacklozenge</code>
$\vdots$	<code>\vdots</code>	$\iiint$	<code>\iiint</code>	$\lozenge$	<code>\lozenge</code>	$\blacksquare$	<code>\blacksquare</code>
$\ldots$	<code>\ldots</code>	$\iint$	<code>\iint</code>	$\mho$	<code>\mho</code>	$\blacktriangle$	<code>\blacktriangle</code>
$\ddots$	<code>\ddots</code>	$\sharp$	<code>\sharp</code>	$\prime$	<code>\prime</code>	$\blacktriangledown$	<code>\blacktriangledown</code>
$\Im$	<code>\Im</code>	$\flat$	<code>\flat</code>	$\square$	<code>\square</code>	$\backprime$	<code>\backprime</code>
$\Re$	<code>\Re</code>	$\natural$	<code>\natural</code>	$\surd$	<code>\surd</code>	$\circledS$	<code>\circledS</code>

## 9 Math mode accents

$\acute{a}$	<code>\acute{a}</code>	$\bar{a}$	<code>\bar{a}</code>	$\acute{A}$	<code>\Acute{\Acute{A}}</code>	$\bar{A}$	<code>\Bar{\Bar{A}}</code>
$\breve{a}$	<code>\breve{a}</code>	$\check{a}$	<code>\check{a}</code>	$\breve{A}$	<code>\Breve{\Breve{A}}</code>	$\check{A}$	<code>\Check{\Check{A}}</code>
$\ddot{a}$	<code>\ddot{a}</code>	$\dot{a}$	<code>\dot{a}</code>	$\ddot{A}$	<code>\Ddot{\Ddot{A}}</code>	$\dot{A}$	<code>\Dot{\Dot{A}}</code>
$\grave{a}$	<code>\grave{a}</code>	$\hat{a}$	<code>\hat{a}</code>	$\grave{A}$	<code>\Grave{\Grave{A}}</code>	$\hat{A}$	<code>\Hat{\Hat{A}}</code>
$\tilde{a}$	<code>\tilde{a}</code>	$\vec{a}$	<code>\vec{a}</code>	$\tilde{A}$	<code>\Tilde{\Tilde{A}}</code>	$\vec{A}$	<code>\Vec{\Vec{A}}</code>

## 10 Array environment, examples

Simplest version:

`\begin{array}{cols} row_1 \\\ row_2 \\\ \dots row_m \end{array}`

where *cols* includes one character `[lrc]` for each column (with optional characters `|` inserted for vertical lines)

and *row<sub>j</sub>* includes character `&` a total of  $(n - 1)$  times to separate the  $n$  elements in the row. Examples:

```
\left( \begin{array}{cc} 2\tau & 7\phi - \frac{5}{12} \\\
3\psi & \frac{\pi}{8} \end{array} \right)
\left( \begin{array}{c} x \\\ y \end{array} \right)
\mbox{\~and~} \left[ \begin{array}{cc|c}
3 & 4 & 5 \\\ 1 & 3 & 729 \end{array} \right]
```

$$\left( \begin{array}{cc} 2\tau & 7\phi - \frac{5}{12} \\ 3\psi & \frac{\pi}{8} \end{array} \right) \left( \begin{array}{c} x \\ y \end{array} \right) \text{ and } \left[ \begin{array}{cc|c} 3 & 4 & 5 \\ 1 & 3 & 729 \end{array} \right]$$

```
f(z) = \left\{ \begin{array}{l} \overline{\overline{z^2 + \cos z}} & \text{for } |z| < 3 \\ 0 & \text{for } 3 \leq |z| \leq 5 \\ \sin \overline{z} & \text{for } |z| > 5 \end{array} \right.
```

$$f(z) = \begin{cases} \overline{z^2 + \cos z} & \text{for } |z| < 3 \\ 0 & \text{for } 3 \leq |z| \leq 5 \\ \sin \bar{z} & \text{for } |z| > 5 \end{cases}$$

## 11 Other Styles (math mode only)

Caligraphic letters: `\mathcal{A}` etc.: *ABCDEFGHIJKLMNOPQRSTUVWXYZ*

Mathbb letters: `\mathbb{A}` etc.: **ABCDEFGHIJKLMNOPQRSTUVWXYZ**

Mathfrak letters: `\mathfrak{A}` etc.: *ABCDEFGHIJKLMNOPQRSTUVWXYZ abc 123*

Math Sans serif letters: `\mathsf{A}` etc.: **ABCDEFGHIJKLMNOPQRSTUVWXYZ abc 123**

Math bold letters: `\mathbf{A}` etc.: **ABCDEFGHIJKLMNOPQRSTUVWXYZ abc 123**

Math bold italic letters: define `\def\mathbi#1{\textbf{\em #1}}` then use `\mathbi{A}` etc.:

***ABCDEFGHIJKLMNOPQRSTUVWXYZ abc 123***

## 12 Font sizes

Math Mode:

$\int f^{-1}(x - x_a) dx$	<code>\displaystyle \int f^{-1}(x-x_a)\,dx</code>
$\int f^{-1}(x - x_a) dx$	<code>\textstyle \int f^{-1}(x-x_a)\,dx</code>
$\int f^{-1}(x - x_a) dx$	<code>\scriptstyle \int f^{-1}(x-x_a)\,dx</code>
$\int f^{-1}(x - x_a) dx$	<code>\scriptscriptstyle \int f^{-1}(x-x_a)\,dx</code>

Text Mode:

<code>\tiny</code> = smallest	<code>\normalsize</code> = normal	<code>\huge</code> = huge
<code>\scriptsize</code> = very small	<code>\large</code> = large	<code>\Huge</code> = Huge
<code>\footnotesize</code> = smaller	<code>\Large</code> = Large	
<code>\small</code> = small	<code>\LARGE</code> = LARGE	

## 13 Text Mode: Accents and Symbols

ó <code>\'o</code>	ö <code>\"o</code>	ô <code>\~o</code>	ò <code>\'o</code>	õ <code>\~o</code>	ō <code>\=o</code>	š <code>\d s</code>
ò <code>\.o</code>	ö <code>\u{o}</code>	ô <code>\H{o}</code>	ô <code>\t{oo}</code>	q <code>\c{o}</code>	q <code>\d{o}</code>	š <code>\r s</code>
o <code>\b{o}</code>	Å <code>\AA</code>	â <code>\aa</code>	ß <code>\ss</code>	ı <code>\i</code>	j <code>\j</code>	š <code>\H s</code>
ø <code>\o</code>	š <code>\t s</code>	š <code>\v s</code>	Ø <code>\O</code>	¶ <code>\P</code>	§ <code>\S</code>	
æ <code>\ae</code>	Æ <code>\AE</code>	† <code>\dag</code>	‡ <code>\ddag</code>	© <code>\copyright</code>	£ <code>\pounds</code>	