

L^AT_EX Math for Undergrads

Rule One Any mathematics at all, even a single character, gets a mathematical setting. Thus, for “the value of x is 7” enter the value of $\$x\$$ is $\$7\$$.

Template Your document should contain at least this.

```
\documentclass{article}
\usepackage{mathtools,amssymb,amsthm} % imports amsmath

\begin{document}
--document body here--
\end{document}
```

Common constructs

x^2 x^2 $\sqrt{2}$, $\sqrt[3]{2}$ $\sqrt[2]{2}$, $\sqrt[n]{3}$
 $x_{i,j}$ $x_{i,j}$ $\frac{2}{3}$, $2/3$ $\frac{2}{3}$, $2/3$

Calligraphic letters Use as in \mathcal{A} .

ABCDEFGHIJKLMNOPQRSTUVWXYZ

Get script letters, such as \mathscr{P} from \mathscr{P} , by putting `\usepackage{mathrsfs}` in the preamble.

Greek

α <code>\alpha</code>	ξ , Ξ <code>\xi</code> , <code>\Xi</code>
β <code>\beta</code>	\circ <code>o</code>
γ , Γ <code>\gamma</code> , <code>\Gamma</code>	π , Π <code>\pi</code> , <code>\Pi</code>
δ , Δ <code>\delta</code> , <code>\Delta</code>	ϖ <code>\varpi</code>
ϵ <code>\epsilon</code>	ρ <code>\rho</code>
ε <code>\varepsilon</code>	ϱ <code>\varrho</code>
ζ <code>\zeta</code>	σ , Σ <code>\sigma</code> , <code>\Sigma</code>
η <code>\eta</code>	ς <code>\varsigma</code>
θ , Θ <code>\theta</code> , <code>\Theta</code>	τ <code>\tau</code>
ϑ <code>\vartheta</code>	υ , Υ <code>\upsilon</code> , <code>\Upsilon</code>
ι <code>\iota</code>	ϕ , Φ <code>\phi</code> , <code>\Phi</code>
κ <code>\kappa</code>	φ <code>\varphi</code>
λ , Λ <code>\lambda</code> , <code>\Lambda</code>	χ <code>\chi</code>
μ <code>\mu</code>	ψ , Ψ <code>\psi</code> , <code>\Psi</code>
ν <code>\nu</code>	ω , Ω <code>\omega</code> , <code>\Omega</code>

Sets and logic

\cup <code>\cup</code>	\mathbb{R} <code>\mathbb{R}</code>	\forall <code>\forall</code>
\cap <code>\cap</code>	\mathbb{Z} <code>\mathbb{Z}</code>	\exists <code>\exists</code>
\subset <code>\subset</code>	\mathbb{Q} <code>\mathbb{Q}</code>	\neg <code>\neg</code>
\subseteq <code>\subseteq</code>	\mathbb{N} <code>\mathbb{N}</code>	\vee <code>\vee</code>
\supset <code>\supset</code>	\mathbb{C} <code>\mathbb{C}</code>	\wedge <code>\wedge</code>
\supseteq <code>\supseteq</code>	\emptyset <code>\emptyset</code>	\vdash <code>\vdash</code>
\in <code>\in</code>	\emptyset <code>\emptyset</code>	\models <code>\models</code>
\notin <code>\notin</code>	\aleph <code>\aleph</code>	\setminus <code>\setminus</code>

Negate an operator, as in $\not\subset$, with `\not\subset`. Get the set complement A^c with `A^{\complement}` (or A^c with `A^{\complement}`, or \overline{A} with `\overline{A}`).

Decorations

f' <code>f'</code>	\dot{a} <code>\dot{a}</code>	\tilde{x} <code>\tilde{x}</code>
f'' <code>f''</code>	\ddot{a} <code>\ddot{a}</code>	\bar{x} <code>\bar{x}</code>
Σ^* <code>\Sigma^*</code>	\hat{x} <code>\hat{x}</code>	\vec{x} <code>\vec{x}</code>

If the decorated letter is i or j then some decorations need `\imath` or `\jmath`, as in $\vec{\imath}$. Some authors use boldface for vectors: `\boldsymbol{x}`.

Entering `\overline{x+y}` produces $\overline{x+y}$, and `\widehat{x+y}` gives $\widehat{x+y}$. Comment on an expression as here (there is also `\overbrace{...}`).

$\underbrace{x+y}_{|A|}$ `\underbrace{x+y}_{|A|}`

Dots Use low dots in a list $\{0, 1, 2, \dots\}$, entered as `\{0,1,2,\,\,\ldots\}`. (If you use `\ldots` in plain text as with London, Paris, `\ldots`, then note the `\thinspace`, before the period.) Use centered dots in a sum or product $1 + \dots + 100$, entered as `1+\cdots+100`. You can also get vertical dots `\vdots` and diagonal dots `\ddots`.

Roman names Enter `\tan(x)`, with a backslash, instead of `tan(x)`. These get the same treatment.

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

Other symbols

$<$ <code><</code>	\angle <code>\angle</code>	\cdot <code>\cdot</code>
\leq <code>\leq</code>	\measuredangle <code>\measuredangle</code>	\pm <code>\pm</code>
$>$ <code>></code>	ℓ <code>\ell</code>	\mp <code>\mp</code>
\geq <code>\geq</code>	\parallel <code>\parallel</code>	\times <code>\times</code>
\neq <code>\neq</code>	45° <code>45^{\circ}</code>	\div <code>\div</code>
\ll <code>\ll</code>	\cong <code>\cong</code>	$*$ <code>\ast</code>
\gg <code>\gg</code>	\ncong <code>\ncong</code>	$ $ <code>\mid</code>
\approx <code>\approx</code>	\sim <code>\sim</code>	\nmid <code>\nmid</code>
\asymp <code>\asymp</code>	\simeq <code>\simeq</code>	$n!$ <code>n!</code>
\equiv <code>\equiv</code>	\nsim <code>\nsim</code>	∂ <code>\partial</code>
\prec <code>\prec</code>	\oplus <code>\oplus</code>	∇ <code>\nabla</code>
\preceq <code>\preceq</code>	\ominus <code>\ominus</code>	\hbar <code>\hbar</code>
\succ <code>\succ</code>	\odot <code>\odot</code>	\circ <code>\circ</code>
\succeq <code>\succeq</code>	\otimes <code>\otimes</code>	\star <code>\star</code>
\propto <code>\propto</code>	\oslash <code>\oslash</code>	\surd <code>\surd</code>
\doteq <code>\doteq</code>	\upharpoonright <code>\upharpoonright</code>	\checkmark <code>\checkmark</code>

Use `a\mid b` for the divides relation, $a \mid b$, and `a\nmid b` for the negation, $a \nmid b$. Also use `\mid` to get set builder notation $\{a \in S \mid a \text{ is odd}\}$, with `\{a\in S\mid\text{\textit{\$a\$ is odd}}\}`.

Arrows

\rightarrow <code>\rightarrow</code>	\mapsto <code>\mapsto</code>
\nrightarrow <code>\nrightarrow</code>	\longmapsto <code>\longmapsto</code>
\longrightarrow <code>\longrightarrow</code>	\leftarrow <code>\leftarrow</code>
\Rightarrow <code>\Rightarrow</code>	\leftrightharpoonup <code>\leftrightharpoonup</code>
\nRightarrow <code>\nRightarrow</code>	\downarrow <code>\downarrow</code>
\Longrightarrow <code>\Longrightarrow</code>	\uparrow <code>\uparrow</code>
\rightsquigarrow <code>\rightsquigarrow</code>	\updownarrow <code>\updownarrow</code>

The right arrows in the first column have matching left arrows, such as `\nleftarrow`, and there are some other matches for down arrows, etc.

Variable-sized operators The summation $\sum_{j=0}^3 j^2$
`\sum_{j=0}^3 j^2` and the integral $\int_{x=0}^3 x^2 dx$
`\int_{x=0}^3 x^2 \, dx` expand when displayed.

$$\sum_{j=0}^3 j^2 \quad \int_{x=0}^3 x^2 dx$$

These do the same.

$$\int \int \int \iiint \bigcup \bigcap$$

Fences

$$\begin{array}{llll} () & () & \langle \rangle & \langle \rangle \\ [] & [] & \lfloor \rfloor & \lfloor \rfloor \\ \{ \} & \{ \} & \lceil \rceil & \lceil \rceil \end{array}$$

Fix the size with `\big`, `\Big`, `\bigg`, or `\Bigg`.

$$\left[\sum_{k=0}^n e^{k^2} \right] \quad \Big[\sum_{k=0}^n e^{k^2} \Big]$$

To have them grow with the enclosed formula, use `\left` and `\right` (although sometimes `\big`, etc., are necessary).

$$\left\langle i, 2^{2^i} \right\rangle \quad \left\langle i, 2^{2^i} \right\rangle$$

Every `\left` must match a `\right` and they must end on the same line in the output. For a one-sided fence, put a `\left.` or `\right.` on the other side.

$$\left. \frac{df}{dx} \right|_{x_0} \quad \left. \frac{df}{dx} \right|_{x_0}$$

Arrays, Matrices Make an array of mathematical text as you make a table of plain text.

$$\begin{array}{ll} 0 & \leftrightarrow 0 \\ 1 & \leftrightarrow 1 \\ 2 & \leftrightarrow 4 \\ \vdots & \vdots \end{array}$$

Definition by cases is an array with two columns.

$$f_n = \begin{cases} a & \text{if } n = 0 \\ r \cdot f_{n-1} & \text{else} \end{cases}$$

A matrix is an array with fences. With a `pmatrix` environment, you need not specify column alignments.

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}$$

For the determinant use `|A|` inline and `vmatrix` in display.

Spacing in mathematics Improve $\sqrt{2}x$ to $\sqrt{2}x$ with a thin space, as in `\sqrt{2}\,x`. Slightly wider are `\:` and `\;` (the three are in ratio 3 : 4 : 5). Get the improvement of $n/\log n$ instead of $n/\log n$ by using a negative thin space, as in `n/\!\!\!\log n`. Bigger spaces are: `\quad` for $\rightarrow \leftarrow$, and `\qquad` for $\rightarrow \leftarrow$, which are useful between parts of a display. Get arbitrary space as in `\hspace*{0.5cm}`.

Displayed equations The `equation*` environment puts an equation on a separate line.

$$S = k \cdot \lg W$$

You can break into multiple lines.

$$\sin(x) = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \dots$$

Align equations using `align*`

$$\begin{aligned} \nabla \cdot \boldsymbol{D} &= \rho \\ \nabla \cdot \boldsymbol{B} &= 0 \end{aligned}$$

(the left or right side of an alignment can be empty). For each environment, get a numbered version by dropping the asterisk from the name.

Calculus examples The last three here are display style.

$$f: \mathbb{R} \rightarrow \mathbb{R} \quad f: \mathbb{R} \rightarrow \mathbb{R}$$

$$9.8 \text{ m/s}^2 \quad 9.8 \text{ m/s}^2$$

$$\lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h} \quad \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

$$\int x^2 dx = x^3/3 + C \quad \int x^2 \, dx = x^3/3 + C$$

$$\nabla = i \frac{d}{dx} + j \frac{d}{dy} + k \frac{d}{dz} \quad \nabla = i \frac{d}{dx} + j \frac{d}{dy} + k \frac{d}{dz}$$

Discrete mathematics examples There are four modulo forms: $m \bmod n$ is from `m\bmod n`, and $a \equiv b \pmod m$ is from `a\equiv b\pmod m`, and $a \equiv b \pmod m$ is from `a\equiv b\pmod m`, and $a \equiv b \pmod m$ is from `a\equiv b\pmod m`.

For combinations the binomial symbol $\binom{n}{k}$ is from `\binom{n}{k}`. This resizes to be bigger in a display (to require the display version use `\dbinom{n}{k}` and require the inline version with `\tbinom{n}{k}`).

For permutations use n^r from `n^{\underline{r}}` (some authors use $P(n, r)$, or ${}_nP_r$ from `\{ \}_nP_r`).

Statistics examples

$$\sigma^2 = \sqrt{\sum (x_i - \mu)^2 / N} \quad \sigma^2 = \sqrt{\sum (x_i - \mu)^2 / N}$$

$$E(X) = \mu_X = \sum (x_i - P(x_i)) \quad E(X) = \mu_X = \sum (x_i - P(x_i))$$

The probability density of the normal distribution

$$\frac{1}{\sqrt{2\sigma^2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

comes from this.

$$\frac{1}{\sqrt{2\sigma^2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

For more See also the Comprehensive L^AT_EX Symbols List at mirror.ctan.org/info/symbols/comprehensive and DeT_EXify at detexify.kirelabs.org/classify.html.