

L^AT_EX Math for Undergrads

Rule One Any mathematics at all, even a single character, goes in a mathematical setting. Thus, for “the value of x is 7” enter ‘the value of $\langle x \rangle$ is $\langle 7 \rangle$ ’.

Template Your document should contain at least this.

```
\documentclass{article}
\usepackage{amsmath, amssymb, amsthm}
\usepackage[utf8]{inputenc}

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

Common constructs

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

Calligraphic letters Use as $\langle \mathcal{A} \rangle$.

ABCDEFGHIJKLMN^OPQRSTU^VW^XY^Z

Greek

α <code>\alpha</code>	ξ, Ξ <code>\xi, \Xi</code>
β <code>\beta</code>	\circ <code>o</code>
γ, Γ <code>\gamma, \Gamma</code>	π, Π <code>\pi, \Pi</code>
δ, Δ <code>\delta, \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, \Sigma</code>
η <code>\eta</code>	ς <code>\varsigma</code>
θ, Θ <code>\theta, \Theta</code>	τ <code>\tau</code>
ϑ <code>\vartheta</code>	υ, Υ <code>\upsilon, \Upsilon</code>
ι <code>\iota</code>	ϕ, Φ <code>\phi, \Phi</code>
κ <code>\kappa</code>	φ <code>\varphi</code>
λ, Λ <code>\lambda, \Lambda</code>	χ <code>\chi</code>
μ <code>\mu</code>	ψ, Ψ <code>\psi, \Psi</code>
ν <code>\nu</code>	ω, Ω <code>\omega, \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>
\ni <code>\ni</code>	\aleph <code>\aleph</code>	\Rightarrow <code>\Rightarrow</code>
\notin <code>\notin</code>	\setminus <code>\setminus</code>	\nRightarrow <code>\nRightarrow</code>
\notin <code>\notin</code>	\equiv <code>\equiv</code>	

Negate an operator, as in $\not\subset$, with `\not\subset`. Get the set complement A^c with `A~{\mathsf{c}}`, get A^0 with `A~{\complement}`, or get \bar{A} with `\bar{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{...}`).

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

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 London, Paris, `\ldots`, 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>	\sphericalangle <code>\sphericalangle</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>*</code>
\gg <code>\gg</code>	\ncong <code>\ncong</code>	$ $ <code> </code>
\approx <code>\approx</code>	\sim <code>\sim</code>	\dagger <code>\dagger</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>

Enter `a|b` for the divides relation $a|b$. Use `\mid` as in `\{a\in S\mid\text{text}\{a=0\}` or `\{(a) is odd\}` for the set $\{a \in S \mid a = 0 \text{ or } a \text{ is odd}\}$.

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 <code>\int</code>	\iiint <code>\iiint</code>	\bigcup <code>\bigcup</code>
\iint <code>\iint</code>	\oint <code>\oint</code>	\bigcap <code>\bigcap</code>

Arrows

\rightarrow	<code>\rightarrow, \to</code>	\mapsto	<code>\mapsto</code>
\rightharpoonup	<code>\rightharpoonup</code>	\longmapsto	<code>\longmapsto</code>
\longrightarrow	<code>\longrightarrow</code>	\leftarrow	<code>\leftarrow</code>
\Rightarrow	<code>\Rightarrow</code>	\Leftrightarrow	<code>\Leftrightarrow</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.

Fences

$()$	<code>()</code>	$\langle \rangle$	<code>\langle \rangle</code>	$ $	<code> </code>	$ $	<code> </code>
$[]$	<code>[]</code>	$\lfloor \rfloor$	<code>\lfloor \rfloor</code>	$ $	<code> </code>	$\backslash \backslash$	<code>\backslash \backslash</code>
$\{ \}$	<code>\{ \}</code>	$\lceil \rceil$	<code>\lceil \rceil</code>				

They will grow with the enclosed formula using `\left` and `\right`.

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

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

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

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

$$\Bigg[\sum_{k=0}^n e^{k^2} \Bigg]$$

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

0	\leftrightarrow	0	<code>\begin{array}{rcl}</code>
1	\leftrightarrow	1	<code>0 & \leftarrow & 0 \\</code>
2	\leftrightarrow	4	<code>1 & \leftarrow & 1 \\</code>
			<code>2 & \leftarrow & 4 \\</code>
			<code>\vdots & & \\</code>
			<code>\end{array}</code>

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 another array variant. With this abbreviation 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

$\rightarrow \leftarrow$	<code>\,</code>	$\rightarrow \leftarrow$	<code>\quad</code>
$\rightarrow \leftarrow$	<code>\:</code>	$\rightarrow \leftarrow$	<code>\quad</code>
$\rightarrow \leftarrow$	<code>\;</code>	$\rightarrow \leftarrow$	<code>\!</code>

The left column spaces are in ratio 3 : 4 : 5. The last in the right column is a negative space, opposite to `\,`. Get arbitrary space as in `\hspace{0.5cm}`.

Displayed equations Put equations on a separate line with the `equation*` environment.

$$S = k \log W$$

You can break into multiple lines.

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

Align using the `align*` environment

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

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

Calculus examples The last three here are display style.

$$\begin{aligned} f: \mathbb{R} &\rightarrow \mathbb{R} & f \text{ colon } \mathbb{R} \text{ to } \mathbb{R} \\ 9.8 \text{ m/s}^2 & & 9.8 \text{ m/s}^2 \\ \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h} & & \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h} \\ \int x^2 dx &= x^3/3 + C & \int x^2 dx = x^3/3 + C \\ \nabla &= i \frac{d}{dx} + j \frac{d}{dy} + k \frac{d}{dz} & \nabla = \mathbf{i} \frac{d}{dx} + \mathbf{j} \frac{d}{dy} + \mathbf{k} \frac{d}{dz} \end{aligned}$$

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 $a \equiv b (m)$ is from `a\equiv b(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 for the inline version use `\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

$$\begin{aligned} \sigma^2 &= \sqrt{\sum (x_i - \mu)^2 / N} & \sigma^2 = \sqrt{\sum (x_i - \mu)^2 / N} \\ E(X) &= \mu_X = \sum (x_i - P(x_i)) & E(X) = \mu_X = \sum (x_i - P(x_i)) \end{aligned}$$

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.