

L^AT_EX Math Mode

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Math Mode

L^AT_EX has a special mode for formatting mathematical formulas. In addition to displaying complicated mathematical notations, this mode allows the use of:

- Subscripts and superscripts
- Greek letters and various special symbols

Thus, math mode is also useful for some nonmathematical text:

The CH₃COOH was irradiated with α -rays while at a temperature of 350°C.

Types of Math Mode

1. *Text math mode* (`\begin{math}...``\end{math}`): the formula appears in the middle of running text (e.g. $x^2 + y^2$).
2. *Display math mode* (`\begin{displaymath}...``\end{displaymath}`): the formula is set off on its own line.

$$\int_0^{\infty} \frac{\sin x}{x} = \frac{\pi}{2}.$$

A special type of this mode is *equation mode* (`\begin{equation}...``\end{equation}`), in which the formula is numbered for reference purposes (1):

$$H : I \rightarrow \pi_k(GL_{2n}(\mathbb{C})), H_t = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}^t \cdot \begin{pmatrix} 1 & 0 \\ 0 & B \end{pmatrix} \cdot \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}^t \quad (1)$$

Long or tall or important formulae should ordinarily be displayed.

Using Math Mode

There are several shorthand techniques of using math mode.

- For text math mode, use $\$. . . \$$ (recommended) or $\langle . . . \rangle$.
- For display math mode, use $$$. . . $$$ or $\langle . . . \rangle$.

It is important to make sure that the way you end math mode matches the way you started it. For example,

```
\begin{math} math stuff $
```

will not work.

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Example

```
For  $a \in A = \mathcal{O}_{V,W}$ , let  
[\ord_V(a) = l_A(A/(a)) \]  
denote the length of  $A/(a)$   
as an  $A$ -module: we extend this as  
[\ord_V\left(\frac{a}{b}\right)  
= \ord_V(a) - \ord_V(b). \] Then,  
for  $r \in R(W_i)$ , we construct  
the divisor  
[\  
\divv(r) = \sum_{\substack{V  
\subset W \\ \text{codim}(V) = 1}} \ord_V(r)[V].  
 \]
```

For $a \in A = \mathcal{O}_{V,W}$, let

$$\text{ord}_V(a) = l_A(A/(a))$$

denote the length of $A/(a)$ as an A -module: we extend this as

$$\text{ord}_V\left(\frac{a}{b}\right) = \text{ord}_V(a) - \text{ord}_V(b).$$

Then, for $r \in R(W_i)$, we construct the divisor

$$\text{div}(r) = \sum_{\substack{V \subset W \\ \text{codim}(V)=1}} \text{ord}_V(r)[V].$$

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Typing Mathematical Expressions

- Numbers, Roman variable names, and most symbols of basic arithmetic may be typed directly:

If $a + 2 = 4 + b$ and
 $2(3b - a) = 43$,
then $b = 47/4$.

If $a + 2 = 4 + b$ and $2(3b - a) = 43$,
then $b = 47/4$.

- Spaces are generally ignored in math mode: $\$abc+def\$$ and $\$a b c + d e f\$$ both make $abc + def$.

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Typefaces in Math Mode

Letters typed in math mode are set in an italic type, as is conventional for Roman variables (x , etc.).

But do not use this as a quick way to italicize ordinary text! Words typed in math mode look *really freakin' ugly* (that was $\$really\ freakin'\ ugly\$$). Use $\emph{\dots}$ instead.

If you want to put text inside math mode, you can use your text here . If that doesn't work, add $\usepackage{amsmath}$ before the line $\begin{document}$, or use $\text{rm}\text{your text here}$.

For \sin , \cos , \lim , and other notations written in upright type, use commands \sin , \cos , \lim , and so forth.

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Super- and Subscripts

To get a superscript, use `^{text}`. To get a subscript, use `_{text}`.

Both a subscript and a superscript can be placed on the same expression.

To get a ' (prime), use ' repeated as many times as needed.

Examples:

| Command | Result | Command | Result |
|--------------------------|-------------|--------------------------|-------------|
| <code>a^{b}</code> | a^b | <code>a^{b + c}</code> | a^{b+c} |
| <code>a'</code> | a' | <code>a''''</code> | a'''' |
| <code>a_{b}</code> | a_b | <code>a_{b + c}</code> | a_{b+c} |
| <code>a_{0}^{n+1}</code> | a_0^{n+1} | <code>a^{n+1}_{0}</code> | a_0^{n+1} |
| <code>x^{y^{z}}</code> | x^{y^z} | <code>a_{b_{c}}</code> | a_{bc} |

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Nonmath Uses of Math Mode

Subscripts and superscripts are often useful in chemical formulae and temperature values.

| Text | Result |
|-------------------------------|--------------------------|
| <code>CH\$_{3}\$COOH</code> | CH_3COOH |
| <code>180\$\^{circ}\$C</code> | 180°C |
| <code>\$^{238}_{92}\$U</code> | ${}^{238}_{92}\text{U}$ |

Notice that subscripts and superscripts may be attached to nothing (as in `$_{3}$` in the formula for acetic acid above).

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Variables and Symbols in Math Mode

Greek letters: for lowercase, use `\lettername` in math mode (`$$\gamma$` $\rightarrow \gamma$). Some uppercase letters can be obtained by `\Lettername` (`$$\Gamma$` $\rightarrow \Gamma$).

Assignment 1: Open `math.tex` in your MiniPaper directory, and typeset the following sentence into the body of the document.

If $f(\omega) = \omega - e \log \omega$ then $f'(\omega) = 1 - e/\omega$ and $e^{f(\omega)} = \Omega(1)$ in positive ω .

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Assignment 1 solution

If `$$f(\omega) = \omega - e \log \omega$` then `$$f'(\omega) = 1 - e/\omega$` and `$$e^{f(\omega)} = \Omega(1)$` in positive `$$\omega$`.

If $f(\omega) = \omega - e \log \omega$ then $f'(\omega) = 1 - e/\omega$ and $e^{f(\omega)} = \Omega(1)$ in positive ω .

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Fractions and Roots

Fraction: use `\frac{numerator}{denominator}` (`\frac{3}{5}` → $\frac{3}{5}$).
(In text math mode, the slashed forms `n/d` usually look better.)

Square root: use `\sqrt{...}` (`\sqrt{3x + 5}` → $\sqrt{3x + 5}$).

n^{th} power root: use `\sqrt[n]{...}` (`\sqrt[3]{x}` → $\sqrt[3]{x}$).

Assignment 2: Typeset the equation

$$\frac{1}{1 + \sqrt[3]{2} + \sqrt[3]{4}} = \sqrt[3]{2} - 1 \quad (2)$$

Note that it is numbered.

Assignment 2 solution

```
\begin{equation}
\frac{1}{1 + \sqrt[3]{2}
+ \sqrt[3]{4}} =
\sqrt[3]{2} - 1
\end{equation}
```

$$\frac{1}{1 + \sqrt[3]{2} + \sqrt[3]{4}} = \sqrt[3]{2} - 1 \quad (3)$$

Common Mathematical Functions

Most common mathematical functions and operators have corresponding commands which are just names of the functions:

- Summation (Σ), product (Π), and integral (\int) signs are given by `\sum`, `\prod`, and `\int` respectively.
- `\lim`, `\log`, `\sin`, `\cos`, `\tan`, `\sec`, `\csc`, `\cot` yield proper formatting of these common functions.

| Command | Result |
|--------------------------------|------------------|
| <code>\log (3x + 5)</code> | $\log(3x + 5)$ |
| <code>\cos (5x + x^2)</code> | $\cos(5x + x^2)$ |
| <code>\sin^{2} (4x + 7)</code> | $\sin^2(4x + 7)$ |

Common Mathematical Symbols

Most common mathematical symbols have corresponding commands related to the symbol name or symbol appearance.

| Command | Result | Command | Result |
|-------------------------|--------------|-------------------------------|--------------------|
| <code>\in</code> | \in | <code>\nabla</code> | ∇ |
| <code>\cap, \cup</code> | \cap, \cup | <code>\subset, \supset</code> | \subset, \supset |
| <code>\geq, \leq</code> | \geq, \leq | <code>\ldots, \cdots</code> | \dots, \cdots |

To negate $=$ and \in , use `\neq` and `\notin`. Other symbols can be negated using the `\not` command: `\not\leq` → $\not\leq$, `\not>` → $\not>$.

Assignment 3: Typeset the following.

If $A, B \subset \Gamma$ then $(\Gamma - A \cup B) \subset (\Gamma - A \cap B)$.

Assignment 3 solution

If $A, B \subset \Gamma$ then
 $(\Gamma - A) \cup B \subset \Gamma - A \cap B$.

If $A, B \subset \Gamma$ then $(\Gamma - A \cup B) \subset (\Gamma - A) \cap B$.

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Bounded Sums and Such

Sums, products, integrals, and the like often have written upper and lower bounds. These can be indicated using $_$ for the lower bound and $^$ for the upper bound:

$\sum_{i=-N}^N$
 $\sum_{j \geq 0}$
 $\frac{1}{i^2 + j^3}$

$$\sum_{i=-N}^N \sum_{j \geq 0} \frac{1}{i^2 + j^3}$$

To best display unions and intersections that are bounded, use \bigcup and \bigcap instead of \cup and \cap .

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Sum, Integral, Limit Examples

In text:

$\sum_{i=1}^{\infty} i^{-2}$

$$\sum_{i=1}^{\infty} i^{-2}$$

$\int_3^{2x} y \, dy$

$$\int_3^{2x} y \, dy$$

$\lim_{n \rightarrow \infty} \frac{1}{n}$

$$\lim_{n \rightarrow \infty} \frac{1}{n}$$

In displays:

$\sum_{i=1}^{\infty} i^{-2}$

$$\sum_{i=1}^{\infty} i^{-2}$$

$\int_3^{2x} y \, dy$

$$\int_3^{2x} y \, dy$$

$\lim_{n \rightarrow \infty} \frac{1}{n}$

$$\lim_{n \rightarrow \infty} \frac{1}{n}$$

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Union and Intersection Examples

In text:

$\bigcap_{i=0}^{\infty} U_i$

$$\bigcap_{i=0}^{\infty} U_i$$

$\bigcup_{k=3}^n \{1, 2, \dots, k\}$

$$\bigcup_{k=3}^n \{1, 2, \dots, k\}$$

In displays:

$\bigcap_{i=0}^{\infty} U_i$

$$\bigcap_{i=0}^{\infty} U_i$$

$\bigcup_{k=3}^n \{1, 2, \dots, k\}$

$$\bigcup_{k=3}^n \{1, 2, \dots, k\}$$

$(\bigcup_i U_i) \cup (\bigcup_i V_i)$

$$\left(\bigcup_i U_i \right) \cup \left(\bigcup_i V_i \right)$$

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Assignment 7—Integrals, roots, exponents

Typeset the following equations:

$$\lim_{\min\{x,y\} \rightarrow \infty} \frac{x+y}{x^2+y^2} = 0 \quad (4)$$

$$\int_{-\infty}^{\infty} e^{-x^2} dx = \sqrt{\pi} \quad (5)$$

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Assignment 7 solution

```
\begin{equation}
\lim_{\min\{x,y\} \to \infty}
\frac{x+y}{x^2+y^2} = 0
\end{equation}
\begin{equation}
\int_{-\infty}^{\infty}
e^{-x^2} dx = \sqrt{\pi}
\end{equation}
```

$$\lim_{\min\{x,y\} \rightarrow \infty} \frac{x+y}{x^2+y^2} = 0 \quad (5)$$

$$\int_{-\infty}^{\infty} e^{-x^2} dx = \sqrt{\pi} \quad (6)$$

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Mathematical fonts

- Various fonts can be used to create unique mathematical symbols:

| | | |
|-----------------|---------------|---------------|
| Bold | \mathbf{x} | \mathbf{x} |
| Calligraphic | \mathcal{A} | \mathcal{A} |
| Blackboard bold | \mathbb{Z} | \mathbb{Z} |
| Script | \mathscr{O} | \mathscr{O} |

Assignment 8: Typeset the following equation.

$$\mathbb{R}^s \supset \mathbf{I}$$

Note: the “I” is bold.

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Assignment 8 solution

```
\begin{displaymath}
\mathbb{R}^s \supset \mathbf{I}
\end{displaymath}
```

$$\mathbb{R}^s \supset \mathbf{I}$$

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Common Error Messages

```
! Missing $ inserted.
```

```
<inserted text>
```

```
      $
```

```
1.8
```

```
?
```

You have forgotten to end math mode. The line number after the “1.” (in this case “8”) is the first line at which \LaTeX has realized that you have forgotten to end math mode; it is usually the end of the paragraph the error is in.

Common cause: Forgetting to put a `\` before a `%`.

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Common Error Messages

```
! Missing $ inserted.
```

```
<inserted text>
```

```
      $
```

```
1.6 30^
```

```
      \circ
```

```
?
```

You have used a command (in this case `^`) which \LaTeX knows belongs only in math mode. The line number given is the location of the command in question.

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Common Error Messages

```
! LaTeX Error: \begin{displaymath} on input line 8 ended by
\end{document}.
```

See the \LaTeX manual or \LaTeX Companion for explanation.

Type `H` `<return>` for immediate help.

```
...
```

```
1.10 \end{document}
```

```
?
```

You have forgotten to end display math mode. The line number on which math mode began is listed (in this case, “input line 8”).

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Common Error Messages

```
! LaTeX Error: \mathbb allowed only in math mode.
```

See the \LaTeX manual or \LaTeX Companion for explanation.

Type `H` `<return>` for immediate help.

```
...
```

```
1.6 \mathbb
```

```
      {stuff}
```

```
?
```

The command in question (in this case `\mathbb`) is only allowed in math mode and you have tried to use it outside of math mode.

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