Math in LaTeX

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1 General Information

Special Characters: # $ % & { } _ ~ ^ \. The first seven can be generated with \ followed by the character.

Quotation marks: ``\ldots'' yields "...".

Dashes: - (hyphen -), -- (range –), and --- (dash —).

Spaces between words don't matter a bit. Forced hyphenation can be done this way: hy\-phen\-a\-tion.

\emph{Emphasized Text} = *Emphasized Text*
{\bf Bold Text} = **Bold Text**
{\tt Typewriter Text} = `Typewriter Text`

To prevent line breaks between certain words, use a ~ in place of a space: Mr. Johns, Figure 7 (Mr.~Johns, Figure~7).

To print long text on a single line, surround it by an \mbox: \mbox{This text will appear on one line.

Footnotes[1] can be printed using \footnote{This is a footnote}.

Comments are done by % characters.

Vertical space can be specified by \vspace{0.25in}

Verbatim text can be done with \verb+Text!+ or the verbatim environment \begin{verbatim} ... \end{verbatim}.

[1] This is a footnote.

Lists types: itemize, enumerate, and description.

```
\begin{itemize}
    \item \begin{description}
        \item[Name1] Description of the Name1 object.
        \item[Name2] Description of the Name2 object.
        \end{description}
    \item \begin{enumerate}
        \item item1
        \item item2
        \end{enumerate}
\end{itemize}
```

- **Name1** Description of the Name1 object.

  Name2 Description of the Name2 object.

- 1. item1
  2. item2

2 Types of Math Environments

Formulas in the middle of text: `\(2x=4\)` or `$2x=4$`. This appears as follows: $2x = 4$ or $2x = 4$. `\begin{math} \end{math}` also works the same.

The displaymath environment offsets equations for emphasis:

```
\begin{displaymath}
    2x=4
\end{displaymath}
```

$$2x = 4$$

The commands `\[ \]` are shortcuts to the displaymath environment.

The equation environment does the same, but numbers the equation:

```
\begin{equation}
    2x=4
    \label{simpleequation}
\end{equation}
```

$$2x = 4 \tag{1}$$

To refer to Equation 1 (`Equation~\ref{simpleequation}`), use a cross-reference. Note that this takes multiple passes of LaTeX. In figures, the label command must go after the caption command.

3 Typical Math Constructs

Exponentiation: `$x^2$` $= x^2$, `$x^{2y}$` $= x^{2y}$, `$x^{4^y}$` $= x^{4^y}$.

Subscripts: `$x_{2}$` $= x_2$, `$x^{y_2}$` $= x^{y_2}$.

Fractions: `$n/(2+m)$` $= n/(2+m)$, `\[ \frac{y+z/2}{y^2+1} \]` $=$

$$\frac{y+z/2}{y^2+1}$$

Ellipsis: `\ldots` $= \ldots$

Roots: `$\sqrt{x+y}$` $= \sqrt{x+y}$, `$\sqrt[n]{x+y}$` $= \sqrt[n]{x+y}$

Greek letters: `\alpha` $= \alpha$, `\beta` $= \beta$, `\delta` $= \delta$, `\Delta` $= \Delta$, `theta` $= \theta$, `\pi` $= \pi$, $\ldots$

Common operators:

```
\times      \div        \pm             \bullet
\cap        \cup        \subset         \supset
\lor        \land       \lnot           \in
\leq        \geq        \neq            \equiv
\infty      \forall     \exists         \emptyset
\leftarrow  \Leftarrow  \leftrightarrow \Leftrightarrow
```

$\times$ $\div$ $\pm$ $\bullet$
$\cap$ $\cup$ $\subset$ $\supset$
$\vee$ $\wedge$ $\neg$ $\in$
$\leq$ $\geq$ $\neq$ $\equiv$
∞ $\forall$ $\exists$ $\emptyset$
$\leftarrow$ $\Leftarrow$ $\leftrightarrow$ $\Leftrightarrow$

3.1 Functions

```
\sum      \prod     \int
\bigcup   \bigcap   \oint
```

$\sum$ $\prod$ $\int$
$\bigcup$ $\bigcap$ $\oint$

These functions all work similar to the following example:
`$\sum_{i=0}^{n} x_i = \int_0^1 f$`. This expression will look this way $\sum_{i=0}^{n} x_i = \int_0^1 f$ when in the text but this way

$$\sum_{i=0}^{n} x_i = \int_0^1 f$$

when in displaymath mode.

Common math functions:

```
\log     \cos     \sin   \tan
\arccos  \arcsin  \cosh  \sinh
\lim     \ln      \max   \min
```

$$\begin{array}{cccc} \log & \cos & \sin & \tan \\ \arccos & \arcsin & \cosh & \sinh \\ \lim & \ln & \max & \min \end{array}$$

Example with limits:

```
\lim_{n \rightarrow \infty} x = 0
```

$\lim_{n \rightarrow \infty} x = 0$ and in displaymath mode:

$$\lim_{n \rightarrow \infty} x = 0$$

Picky things about functions:

- To typeset `{a | a>0}`, try $\{a \mid a > 0\}$. The point is to use `\mid` instead of `|`. The latter has spacing problems.
- To typeset `f: X -> Y`, try $f: X \rightarrow Y$. Use `\colon` instead of `:` to get the correct spacing.
- To typeset multi-character names in math mode, use `\mathit`. For example, doesn't $difference = 1$ look better than $\mathit{difference} = 1$? The commands `\textstyle` (for in-text math) and `\displaystyle` (for displaymath mode) can be used to make plain text in an equation: `\[\displaystyle{Let\,} x=1.\]`

  $$\displaystyle{Let\,} x=1.$$

  Notice the extra space by `\,`! You can also use `\mbox` to make plain text.

You can define your own function in the following manner:

```
\newcommand{\SumToX}[2]{\ensuremath{\sum_{#1=1}^{#2}}}
\newcommand{\QuadraticFormula}[3]{\ensuremath{\frac{-#2 \pm
\sqrt{#2^2 - 4 \times #1 \times #3}}{2 \times #1}}}
```

Then we can use the new commands in our document: `$\SumToX{i}{N}x_i$` $= \sum_{i=1}^{N} x_i$. `\[\QuadraticFormula{a}{b}{c}\] =`

$$\frac{-b \pm \sqrt{b^2 - 4 \times a \times c}}{2 \times a}$$

3.2 Arrays

Note that the `\tabular` environment is very similar to the `\array` environment, except it is for regular text.

```
\( \begin{array}{cl|r}
Name1 & Name2  & Name3 \\ \hline
a     &   xy   &   12  \\
a+b   &   x+y  &   5   \\
a+b+c &   x/y  &   100
\end{array} \)
```

$Name1$	$Name2$	$Name3$
a	xy	12
$a+b$	$x+y$	5
$a+b+c$	x/y	100

Delimiters are often used in combination with arrays. The delimiters automatically scale to encompass the arrays. Use the commands `\left` or `\right` before a delimiter to specify the left or right side. Common delimiters:

```
(          )          [        ]
\{         \}         |        \|
\lfloor    \rfloor    \lceil   \rceil
```

$$(\quad) \quad [\quad]$$
$$\{ \quad \} \quad | \quad \|$$
$$\lfloor \quad \rfloor \quad \lceil \quad \rceil$$

An example:

```
\[ \left( \begin{array}{c}
    \left[ \begin{array}{cc} x_1 & x_2 \\ x_3 & x_4 \end{array} \right]\\
    y \\
    z
    \end{array} \right) \]
```

$$\left(\begin{array}{c} \left[\begin{array}{cc} x_1 & x_2 \\ x_3 & x_4 \end{array} \right] \\ y \\ z \end{array} \right)$$

The argument t aligns the top line of the second array with the center of the first. The argument b would align the bottom line with the center.

```
\[ X = \left[ \begin{array}{c} a_1 \\ \ldots \\ a_n \end{array} \right] -
       \left[ \begin{array}[t]{cc} x-y & x+y \\ xy & x/y \end{array} \right] \]
```

$$X = \left[\begin{array}{c} a_1 \\ \ldots \\ a_n \end{array} \right] - \begin{array}{cc} x-y & x+y \\ xy & x/y \end{array}$$

You can make an invisible delimiter with a "." as follows:

```
\[x = \left\{ \begin{array}{ll}
    y & \mbox{if $y>0$} \\
    0 & \mbox{otherwise}
    \end{array}
    \right. \]
```

$$x = \left\{ \begin{array}{ll} y & \text{if } y > 0 \\ 0 & \text{otherwise} \end{array} \right.$$

3.3 Equation Arrays

Equation arrays allow you to create an aligned series of equations. Each equation can either be numbered (using `\eqnarray`) or unnumbered (using `\eqnarray*`). A `\nonumber` command on a line tells LaTeXto not number that line. Here are two examples:

```
\begin{eqnarray}
x & = & 5y + 6z \\
y & > & a + b + c + d +  \\
  &   & e + f + g \nonumber
\end{eqnarray}

\begin{eqnarray*}
10 & = & 5x \\
x  & = & 10/5 \\
x  & = & 2
\end{eqnarray*}
```

$$\begin{aligned} x &= 5y + 6z && (2) \\ y &> a + b + c + d + \\ &\quad e + f + g && (3) \end{aligned}$$

$$\begin{aligned} 10 &= 2x + 3x \\ 10 &= x(2 + 3) \\ x &= 2 \end{aligned}$$

3.4 Stacking

You can overline with the `\overline` command and underline with the `\underline` command. For example, `$\overline{\overline{y}^3 + 1} = \underline{3x}$` yields $\overline{\overline{y}^3 + 1} = \underline{3x}$.

Overbracing and underbracing works similarly: `$\overbrace{w + \underbrace{x + y}_{12}}^{24}$` yields $\overbrace{w + \underbrace{x + y}_{12}}^{24}$.

Some common math accents:

```
\(\begin{array}{cccc}
\hat{x} & \bar{x} & \vec{x} & \dot{x}
\end{array} \)
```

$\hat{x}$ $\bar{x}$ $\vec{x}$ $\dot{x}$

The letters i and j should not have dots when accented, so use `\imath` and `\jmath` to produce these: $\vec{\imath} + \vec{\jmath}$.

The `\stackrel` command allows us to stack arbitrary symbols:
`$\vec{X}\stackrel{\mathit{def}}{=}(x_1,\ldots, x_n)$` yields $\vec{X} \stackrel{def}{=} (x_1, \ldots, x_n)$.

3.5 Theorems and Such

We can define and automatically number theorems as shown in the following examples:

```
\newtheorem{theorem}{Theorem}
\newtheorem{axiom}{Axiom}

\begin{theorem}
    This is a theorem.
    \label{TheoremThis}
\end{theorem}

\begin{axiom}
    All theorems are dull.
    \label{AxiomDullTheorems}
\end{axiom}
```

Theorem 1 *This is a theorem.*

Axiom 1 *All theorems are dull.*

```
By Axiom~\ref{AxiomDullTheorems}, we can state that
Theorem~\ref{TheoremThis} is dull.
```

By Axiom 1, we can state that Theorem 1 is dull.