LaTeXExamples

Exponents, Subscripts, and Multiplication

LaTeXCode	Typeset output
`$x^2$`	x^2
`$x^{-3}$`	x^{-3}
`$x_1$`	x_1
`$x_1^2$`	x_1^2
`$a \cdot b$`	$a \cdot b$
`$a \times b$`	$a \times b$

Square Root, Cube Root, and n^{th} Roots

LaTeXCode	Typeset output
`$\sqrt{5x + 7}$`	$\sqrt{5x + 7}$
`$\sqrt[3]{x}$`	$\sqrt[3]{x}$
`$\sqrt[n]{x}$`	$\sqrt[n]{x}$

Fractions

LaTeXCode	Typeset output
`$\frac{x^2 + 2x -7}{2x+3}$`	$\frac{x^2 + 2x -7}{2x+3}$
`$\dfrac{x^2 + 2x -7}{2x+3}$`	$\dfrac{x^2 + 2x -7}{2x+3}$

Inequalities

LaTeXCode	Typeset output
`$a < b$`	$a < b$
`$a \leq b$`	$a \leq b$
`$a > b$`	$a > b$
`$a \geq b$`	$a \geq b$
`$a \ne b$`	$a \ne b$

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Basic Functions

LaTeX Code	Typeset output
`$\sin(x)$`	$\sin(x)$
`$\cos(x)$`	$\cos(x)$
`$\tan(x)$`	$\tan(x)$
`$\arcsin(x)$`	$\arcsin(x)$
`$\ln(x)$`	$\ln(x)$

Symbols for the Number Systems

LaTeX Code	Typeset output	
`$\mathbb{N}$`	$\mathbb{N}$	The set of natural numbers
`$\mathbb{Z}$`	$\mathbb{Z}$	The set of integers
`$\mathbb{Q}$`	$\mathbb{Q}$	The set of rational numbers
`$\mathbb{R}$`	$\mathbb{R}$	The set of real numbers
`$\mathbb{C}$`	$\mathbb{C}$	The set of complex numbers

Congruence

LaTeX Code	Typeset output
`$a \equiv b \pmod 8$`	$a \equiv b \pmod 8$
`$a \equiv b \pmod n$`	$a \equiv b \pmod n$
`$(a + b) \equiv c^2 \pmod n$`	$(a + b) \equiv c^2 \pmod n$
`$a \not\equiv b \pmod n$`	$a \not\equiv b \pmod n$

LaTeX Examples

Some Greek Letters and a Hebrew Letter

LaTeX Code	Typeset output
`$\alpha$`	α
`$\beta$`	β
`$\gamma$`	γ
`$\delta$`	δ
`$\epsilon$`	ϵ
`$\theta$`	θ
`$\lambda$`	λ
`$\pi$`	π

LaTeX Code	Typeset output
`$\rho$`	ρ
`$\sigma$`	σ
`$\tau$`	τ
`$\phi$`	ϕ
`$\omega$`	ω
`$\Delta$`	Δ
`$\Sigma$`	Σ
`$\aleph$`	$\aleph$

Some Text Commands

LaTeX Code	Typeset output
`\textbf{Bold Font}`	**Bold Font**
`\textit{Italics}`	*Italics*
`\emph{Emphasized Font}`	*Emphasized Font*
`\large{large font}`	large font
`\Large{Large Font}`	Large Font

Sums and Products

LaTeX Code	Typeset output
`$a_1 + a_2 + \cdots + a_n$`	$a_1 + a_2 + \cdots + a_n$
`$a \cdot b$`	$a \cdot b$
`$a \times b$`	$a \times b$
`$a_1 a_2 \cdots a_n$`	$a_1 a_2 \cdots a_n$

LaTeX Examples

Set Notation

Standard set notation requires the use of braces, { and }. However, braces have a special use in LaTeX code. So we must indicate that the braces we will use are not part of the code. This is done by using `\{` and `\}` to typeset braces.

LaTeX Code	Typeset output
`$A = \{1, 2, 3 \}$`	$A = \{1, 2, 3\}$
`$A = \{1, 2, 3, \ldots  \}$`	$A = \{1, 2, 3, \ldots\}$
`$x \in A$`	$x \in A$
`$x \notin A$`	$x \notin A$
`$A \subseteq B$`	$A \subseteq B$
`$A \subset B$`	$A \subset B$
`$A \cap B$`	$A \cap B$
`$A \cup B$`	$A \cup B$
`$A \times B$`	$A \times B$
`$\emptyset$`	$\emptyset$

- **Roster Method.** To typeset the set $A = \{1, 2, 3\}$, use `$A = \{1, 2, 3 \}$`, or to display it, use

  ```
  \[
  A = \{1, 2, 3\}
  \]
  ```

  To typeset the set $B = \{3, 6, 9, \ldots\}$, use `$B = \{3, 6, 9, \ldots \}$`, or to display it, use

  ```
  \[
  B = \{3, 6, 9, \ldots \}
  \]
  ```

- **Set Builder Notation.** For set builder notation, we need a symbol for the vertical line (|). The best way to handle this is with `\mid`. Here are some examples.
  - To typeset $\{x \in U \mid P(x)\}$, use `$\{ x \in U \mid P(x) \}$`.
  - To typeset $\{x \in \mathbb{R} \mid x^2 < 4\}$, use `$\{ x \in \R \mid x^2 < 4 \}$`.
  - To typeset $A \cap B = \{x \in U \mid x \in A \text{ and } x \in B\}$, use `$A \cap B = \{ x \in U \mid x \in A \text{~and~} x \in B \}$`.

LaTeX Examples

Summation Notation and Product Notation

LaTeX Code	Inline Output	Displayed Output
`\sum_{k=1}^{n}a_k*`	$\sum_{k=1}^{n} a_k$	$\displaystyle\sum_{k=1}^{n} a_k$
`\sum_{k=1}^{n}k^2*`	$\sum_{k=1}^{n} k^2$	$\displaystyle\sum_{k=1}^{n} k^2$
`\sum_{k=1}^{n}\frac{2}{k+1}*`	$\sum_{k=1}^{n} \frac{2}{k+1}$	$\displaystyle\sum_{k=1}^{n} \frac{2}{k+1}$
`\prod_{k=1}^{n}a_k*`	$\prod_{k=1}^{n} a_k$	$\displaystyle\prod_{k=1}^{n} a_k$

Basic In-line Equation

Enclosing an equation inside dollar signs will typeset the equation in the line of text. For example, suppose we want to typeset the following short paragraph:

> We will now consider the equation $x^2 - 3x + 6 = 8$. To solve this equation, we first subtract -8 from both sides of the equation to obtain $x^2 - 3x - 2 = 0$.

To do this, we can use the following LaTeX code:

```
We will now consider the equation $x^2 - 3x + 6 = 8$.  To solve
this equation, we first subtract $-8$ from both sides of the equation
to obtain $x^2 - 3x - 2 = 0$.
```

Displaying a Single Equation

To display the equation $x^2 - 3x + 6 = 8$, use the following LaTeX code:

```
\[
x^2 - 3x + 6 = 8.
\]
```

The typeset result will be

$$x^2 - 3x + 6 = 8.$$

Displaying a List of Equations

To align equations at the equal sign, use the `\align*` environment. Following is an example of a sequence of equations aligned at the equal sign.

$$\begin{aligned} x^2 - 3x + 6 &= 8 \\ x^2 - 3x - 2 &= 0 \\ x &= \frac{3 \pm \sqrt{17}}{2} \end{aligned}$$

To typeset these aligned equations, use the following LaTeX code.

```
\begin{align*}
x^2 - 3x + 6 &= 8 \\
x^2 - 3x - 2 &= 0 \\
x &= \frac{3 \pm \sqrt{17}}{2}
\end{align*}
```

Note: The `\align*` environment suppresses the equation numbers on the equations. To assign numbers to these equations, use the `\align` environment.

Displaying a List of Equations with Comments

To align equations at the equal sign, use the `\align*` environment. Following is an example of a sequence of equations aligned at the equal sign with comments aligned on the right.

$$\begin{aligned} x(y - z) &= x(y + (-z)) && \text{(Definition of Subtraction)} \\ &= xy + x(-z) && \text{(Distributive Law)} \\ &= xy + (-(xz)) && \text{(Property of Signed Numbers)} \\ &= xy - xz && \text{(Definition of Subtraction)} \end{aligned}$$

The LaTeX code that produced this is:

```
\begin{align*}
x( y - z)  &= x(y + (-z))   &  \text{(Definition of Subtraction)} \\
           &= xy + x(-z)    &  \text{(Distributive Law)} \\
           &= xy + (-(xz))  & \text{(Property of Signed Numbers)} \\
           &= xy -xz        & \text{(Definition of Subtraction)}
\end{align*}
```

LaTeX Examples

Equation Numbers

The following LaTeX code will assign a number to a single equation.

```
\begin{equation}
x^2 - 3x - 7 = 0
\end{equation}
```

The typeset result will be

$$x^2 - 3x - 7 = 0 \tag{1}$$

Every equation in an `\align` environment will be numbered. The LaTeX code

```
\begin{align}
x^2 - 3x &= 7 \\
x^2 - 3x - 7 &= 0 \\
x &=\frac{3 \pm \sqrt{37}}{2}
\end{align}
```

produces the following typeset result.

$$\begin{align} x^2 - 3x &= 7 \\ x^2 - 3x - 7 &= 0 \\ x &= \frac{3 \pm \sqrt{37}}{2} \end{align}$$

(2), (3), (4)

To avoid this, use `\notag` after an equation that is not to be numbered.

```
\begin{align}
x^2 - 3x &= 7 \notag \\
x^2 - 3x - 7 &= 0 \notag \\
x &=\frac{3 \pm \sqrt{37}}{2}
\end{align}
```

$$\begin{align} x^2 - 3x &= 7 \notag \\ x^2 - 3x - 7 &= 0 \notag \\ x &= \frac{3 \pm \sqrt{37}}{2} \tag{5} \end{align}$$

Propositions and Theorems

To typeset a proposition, use something like the following:

```
\begin{proposition}
If $x$ and $y$ are odd integers, then $x + y$ is an even integer.
\end{proposition}
```

This will typeset as:

Proposition 1. *If x and y are odd integers, then $x + y$ is an even integer.*

Use the `\proof` environment to include the proof following the proposition. The first line should be `\begin{proof}`. When the proof is complete, use `\end{proof}`. The typeset proposition and proof should look something like the following:

Proposition 1. *If x and y are odd integers, then $x + y$ is an even integer.*

Proof. We assume that x and y are odd integers, and will prove that $x + y$ is an even integer. Since x and y are odd integers, there exist integers m and n such that

$$x = 2m + 1 \quad \text{and} \quad y = 2n + 1.$$

We can then use substitution and algebra to obtain

$$\begin{aligned} x + y &= (2m + 1) + (2n + 1) \\ &= 2m + 2n) + 2 \\ &= 2(m + n + 1) \end{aligned}$$

Since m and n are integers, we conclude that $m + n + 1$ is an integer since the integers are closed under addition. So we see that $x + y = 2(m + n + 1)$ and $(m + n + 1)$ is an integer. So by the definition of an even integer, $x + y$ is an even integer and we have proved that if x and y are odd integers, then $x + y$ is an even integer. ■

Following is the LaTeXcode that produced this proposition and proof:

```
\begin{proposition}
If $x$ and $y$ are odd integers, then $x + y$ is an even integer.
\end{proposition}

\begin{proof}
We assume that $x$ and $y$ are odd integers, and will prove that $x + y$
is an even integer.  Since $x$ and $y$ are odd integers, there exist
integers $m$ and $n$ such that
\[
x = 2m + 1 \text{~~~and~~~} y = 2n + 1.
\]
We can then use substitution and algebra to obtain
\begin{align*}
x + y &= (2m + 1) + (2n + 1) \\
      &= 2m + 2n) + 2 \\
      &= 2(m + n + 1)
\end{align*}
Since $m$ and $n$ are integers, we conclude that $m + n + 1$ is an integer
since the integers are closed under addition.  So we see that
$x + y = 2(m + n + 1)$ and $(m + n +1)$ is an integer.  So by the definition
of an even integer, $x + y$ is an even integer and we have proved that
if $x$ and $y$ are odd integers, then $x + y$ is an even integer.
\end{proof}
```

To label the result as a theorem, use `\begin{theorem}` and `\end{theorem}` instead of `\begin{proposition}` and `\end{propositon}`.

Theorem 2. *If x is an odd integer and y is an even integer, then $x \cdot y$ is an even integer.*

Proof. We assume that x is an odd integer, that y is an even integer, and will prove that $x \cdot y$ is an even integer. Since x is an odd integer and y is an even integer, there exist integers m and n such that

$$x = 2m + 1 \quad \text{and} \quad y = 2n.$$

We can then use substitution and algebra to obtain

$$\begin{aligned} x \cdot y &= (2m + 1) \cdot 2n \\ &= 2n(2m + 1) \end{aligned}$$

Since m and n are integers, we can use the closure properties of the integers to conclude that $n(2m + 1)$ is an integer. So we see that $x \cdot y = 2n(2m+1)$ and $n(2m+1)$ is an integer. Therefore, $x \cdot y$ is an even integer and we have proved that if x is an odd integer and y is an even integer, then $x \cdot y$ is an even integer. ∎

Inserting Graphics in a LaTeX Document

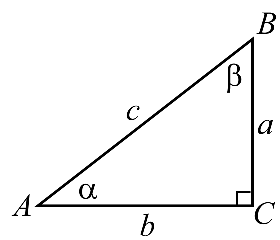
The standard way to insert graphics into a LaTeX document is to use the `\includegraphics` command. The following commands will insert the graphics file "right-triangle.eps" in a document. The graphics file must be contained in the same folder as the LaTeX that is being typeset.

```
\begin{center}
\includegraphics{right-triangle.eps}
\end{center}
```

You can use many types of graphics files with this command. At times, it is convient to use a .pdf file. In that case, the commands would be as follows:

```
\begin{center}
\includegraphics{right-triangle.pdf}
\end{center}
```

Following is the result obtained from either of these two methods.



Numbered and Bulleted Lists in LaTeX

If is often desirable to have a numbered list of items or a bulleted list of items in a document. This can be done in LaTeXusing the `\enumerate` environment or the `\itemize` environonment.

Numbered Lists

Use the `\enumerate` environment as shown in the following example.

```
\begin{enumerate}
  \item When $P$ is true and $Q$ is true, then $P \to Q$ is true.
  \item When $P$ is true and $Q$ is false, then $P \to Q$ is false.
  \item When $P$ is false and $Q$ is true, then $P \to Q$ is true.
  \item When $P$ is false and $Q$ is false, then $P \to Q$ is true.
\end{enumerate}
```

The output will be:

1. When P is true and Q is true, then $P \to Q$ is true.
2. When P is true and Q is false, then $P \to Q$ is false.
3. When P is false and Q is true, then $P \to Q$ is true.
4. When P is false and Q is false, then $P \to Q$ is true.

Bulleted Lists

Use the `\itemize` environment as shown in the following example.

```
\begin{itemize}
  \item When $P$ is true and $Q$ is true, then $P \to Q$ is true.
  \item When $P$ is true and $Q$ is false, then $P \to Q$ is false.
  \item When $P$ is false and $Q$ is true, then $P \to Q$ is true.
  \item When $P$ is false and $Q$ is false, then $P \to Q$ is true.
\end{itemize}
```

The output will be:

- When P is true and Q is true, then $P \to Q$ is true.
- When P is true and Q is false, then $P \to Q$ is false.
- When P is false and Q is true, then $P \to Q$ is true.
- When P is false and Q is false, then $P \to Q$ is true.

Tables in LaTeX

Tables in LaTeX can be difficult to create within a document. The `\tablular` environment is used to create a table in a LaTeX document. Here is a simple table that will be used as an example.

Name	Column 1	Column 2	Column 3
Ted	2.45	34.12	2.19
Karen	1.50	3.12	7.20
Laura	3.17	24.23	11.17

Following is the LaTeX code that produced this table.

```
\begin{center}
\begin{tabular}{| l | c | c | r |}
\hline
Name  & Column 1 & Column 2 & Column 3 \\ \hline
Ted   & 2.45     & 34.12    & 2.19 \\ \hline
Karen & 1.50     & 3.12     & 7.20 \\ \hline
Laura & 3.17     & 24.23    & 11.17 \\ \hline
\end{tabular}
\end{center}
```

Some Notes about This Code

1. `\begin{tabular}` requires an argument consisting of a character l, r, or c (meaning left, right, or center alignment) for each column, and (optionally) the — symbols. Each — indicates a vertical line in the typeset table.

2. Columns are separated by ampersands (&) and rows are separated by `\\`.

3. The ampersands (&) absorb the spaces on either side. So the ampersands do not have to be aligned in the code as shown. However, by doing so, the LaTeX code is more readable by humans.

4. The `\hline` command creates a horizontal line in the typeset table.

5. If you use a horizontal line to finish the table, you must separate the last row of the table from the `\hline` command with the `\\` command.

6. The example shown is a simple table. There are many options in the tabular environment that can be used to create more complicated tables.