

# How to Become a $\text{\LaTeX}$ pert

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# Chapter 1

## A Very Brief Introduction

This guide serves as an introduction to  $\text{\LaTeX}$ . I have tried to make it concise and easy to follow. I am open to criticism (hopefully constructive).

Contact me via [prabhavkumar10@gmail.com](mailto:prabhavkumar10@gmail.com) or [LinkedIn](#).

Updates to this guide can be found on [GitHub](#).



# Chapter 2

## $\text{\LaTeX}$ 101

### 2.1 $\text{\TeX}$

Throughout history, mathematical symbols and equations were written on materials such as clay and paper. With the advent of technology, humans needed a way to write math on computers, so  $\text{\TeX}$  (pronounced “Tech”) was created. It is a computer program created by Donald E. Knuth and short for τέχνη, Greek for both “art” and “craft”.

### 2.2 $\text{\LaTeX}$

$\text{\LaTeX}$  (pronounced “Lah-Tech”) is built on top of  $\text{\TeX}$  and is much more user-friendly. It is created by Leslie Lamport. It is useful to think of  $\text{\TeX}$  as a low-level language and  $\text{\LaTeX}$  as a higher-level language.

#### 2.2.1 The Light-Bulb Analogy

Understanding the difference between  $\text{\TeX}$  and  $\text{\LaTeX}$  can be quite tricky, so a simple light-bulb analogy can be used to explain the difference:

$\text{\TeX}$  and  $\text{\LaTeX}$  can be thought of an electrical circuit and a switch, respectively. Both provide a similar function (lighting up a bulb), but it is much more convenient for the user to deal with the switch than the circuit.

### 2.2.2 Not a Word Processor

L<sup>A</sup>T<sub>E</sub>X is **not** a word processor. When using Microsoft Word, the final document automatically updates while typing on a .docx file. However, with L<sup>A</sup>T<sub>E</sub>X, the final document, which is usually a separate PDF file, only updates after typing and typesetting or compiling a .tex file.

## 2.3 Installing L<sup>A</sup>T<sub>E</sub>X

There are several ways to install L<sup>A</sup>T<sub>E</sub>X, but this is what I did:

1. Download [MikTeX](#) (a T<sub>E</sub>X distribution) .
2. Download [Texmaker](#) (a cross-platform L<sup>A</sup>T<sub>E</sub>X editor).
3. Watch [this](#) video for a guided walkthrough.

# Chapter 3

## Creating your First L<sup>A</sup>T<sub>E</sub>X Document

### 3.1 Before you Start: Typesetting & Troubleshooting

To compile a L<sup>A</sup>T<sub>E</sub>X file, the user must typeset it on Texmaker using the “Quick Build” button (other editors have a “Typeset” or “Compile” button). If a PDF file is outputted, the compilation was successful. If not, then do the following:

1. Click on the “abort” button.
2. Read the console output - it will include the line number and the command that caused the error.
3. Fix the error.
4. Typeset the file again.

As an example, after opening a new document, type the following code:

```
\documentclass[10pt]{article}
```

```
\begin{document}
```

```
Hello World!
```

```
\end{document}
```

Hello World!

As shown, the output should be Hello Word!.

### 3.2 `\documentclass`

`\documentclass` is the command that must appear at the start of a L<sup>A</sup>T<sub>E</sub>X document. The document class is specified within `{ }`. Frequently used classes include:

- `\article` - for shorter documents (notes).
- `\beamer` - for presentation slides.
- `\book` - self-explanatory.
- `\proc` - for conference proceedings.
- `\report` - for longer documents (PhD thesis).

Document class options are specified within `[ ]`. Frequently used options include:

- `xpt` - main font size (default is 10pt).
- `a4paper`, `a5paper`, `letterpaper`, `legalpaper` - paper size.

### 3.3 The Preamble & The Body

Anything before `\begin{document}` is called the preamble and applies to the whole document.

The area between `\begin{document}` and `\end{document}` is called the body. This is where the content goes.

Text after `\end{document}` will be ignored.

#### 3.3.1 `\usepackage`

Sometimes L<sup>A</sup>T<sub>E</sub>X cannot solve a problem, so external packages are added in the preamble using `\usepackage`. For example, `dirtytalk` allows users to deal with quotation marks.

```
\documentclass[10pt]{article}
\usepackage{dirtytalk}
```

```
\begin{document}
\say{Stay positive \& test negative!}
\end{document}
```

“Stay positive & test negative!”

## Creating your First L<sup>A</sup>T<sub>E</sub>X Document

---

You can find package documentation by googling “CTAN \*insert package name\*”.

### 3.3.2 `\title`, `\author`, `\date`, `\maketitle`

When creating a title page, these 4 commands are used. For example, if Einstein (hypothetically) wrote a L<sup>A</sup>T<sub>E</sub>X document, he would type `\title{General Relativity}`, `\author{Albert Einstein}`, `\date{May 7, 1915}` and `\maketitle` in the body.

## 3.4 The Building Blocks of L<sup>A</sup>T<sub>E</sub>X: `\`, `[ ]`, `{ }`, `_`

The backslash is central to L<sup>A</sup>T<sub>E</sub>X because each L<sup>A</sup>T<sub>E</sub>X command starts with `\`.

### 3.4.1 Commands

A command is a special expression that instructs L<sup>A</sup>T<sub>E</sub>X to do a specific task. It is case-sensitive, i.e. `\large` and `\Large` are different commands. Commands are sometimes followed by declarations.

### 3.4.2 Declarations

A declaration is either optional `[ ]` or required `{ }`. For example, in `\documentclass[10pt]{article}`:

- `\documentclass` is the command.
- `[10pt]` is an optional declaration (can be omitted).
- `{article}` is a required declaration (something is needed within `{ }`).

Sometimes `{ }` provides spacing after a command:

`\LaTeX ample` vs. `\LaTeX{} ample`

L <sup>A</sup> T <sub>E</sub> Xample vs. L <sup>A</sup> T <sub>E</sub> X ample
--

### 3.4.3 Environments

An environment performs a specific action on a block of L<sup>A</sup>T<sub>E</sub>X code. It must have matching `\begin` and `\end` declarations. For example:

## Creating your First L<sup>A</sup>T<sub>E</sub>X Document

---

```
\begin{center}
Core-an is the official language at
the center of Earth. \\
P.S. This is how you center text.
\end{center}
```

Core-an is the official language at the  
center of Earth.  
P.S. This is how you center text.

### 3.4.4 Spaces

Spaces and tabs are treated as 1 space (□). Any combination of consecutive spaces and tabs are also treated as 1 space. An empty line marks the end of a paragraph. Consecutive empty lines are treated as 1 empty line. For example:

```
1 space =      1 tab.
1 space =      consecutive spaces.

1 empty line = end of paragraph.

1+ empty lines = 1 empty line.
```

1 space = 1 tab. 1 space = consecutive  
spaces.  
1 empty line = end of paragraph.  
1+ empty lines = 1 empty line.

Use a tilde (~) for an unbreakable space

```
This is an unbreakable space.
Really? Oh Yes. \\
This is an unbreakable space.
Really? Oh~Yes.
```

This is an unbreakable space. Really? Oh  
Yes.  
This is an unbreakable space. Really?  
Oh Yes.

### 3.4.5 Special Characters

#### Reserved Characters

The following characters (discussed elsewhere) have a special meaning in L<sup>A</sup>T<sub>E</sub>X:

# \$ % & { } \_ ~ ^ \

In order to print them, you must escape or prefix the character with a \:

```
\# \$ \% \& \{ \} \_ \~ \^ \\\
\textbackslash
```

# \$ % & { } \_ ~ ^ \

\\ means a newline so \textbackslash is used.

# Creating your First L<sup>A</sup>T<sub>E</sub>X Document

---

## Symbols

There are over 18,000 symbols<sup>1</sup> in L<sup>A</sup>T<sub>E</sub>X. They are printed using specific commands. For example:

```
$\div$ \\  
\copyright \\  
$\clubsuit$
```



Sometimes the symbol must be placed between \$ signs (refer to 7.2 on page 34).

## Helpful Resources

1. [Detexify](#) - inputs a drawing of a symbol and outputs its L<sup>A</sup>T<sub>E</sub>X command (and the package required if needed).
2. [CTAN](#) - a comprehensive list of symbols.

## 3.5 Basic Organization (Section)

It is helpful to divide the L<sup>A</sup>T<sub>E</sub>X document into different sections.

### 3.5.1 Sectioning Commands (Subsection)

Different document classes have different sectioning commands:

#### **article class (Subsubsection)**

- `\section`
- `\subsection`
- `\subsubsection`
- `\paragraph`

---

<sup>1</sup>Some symbols require packages.

# Creating your First L<sup>A</sup>T<sub>E</sub>X Document

---

book, report class (Subsubsection)

- `\part`
- `\chapter`
- All of the article sectioning commands.

Sectioning commands automatically provide spacing (and numbering), so you do not need to add `\newline` or `\\` before the next sectioning command. Add a `*` after the sectioning command for unnumbering. (Paragraph)

```
\section{This will be a numbered section.}
\section*{This will not.}
```

## 3.5.2 Labelling

Section commands can be labelled with `\label{labelname}`. When referring to a particular section, use `\ref{labelname}` (the section) or `\pageref{labelname}` (page number of the section). Using an example from this guide:

```
\label{symbols}
% Some Code
To learn about symbols, refer to
  \ref{symbols} on page
  \pageref{symbols}.
```

To learn about symbols, refer to 3.4.5 on page 13.

## 3.5.3 Footnotes

`\footnote` prints text at the bottom of the page<sup>2</sup>. Here is the code I used to create the footnote:

```
$\ldots$ at the bottom of the
page\footnote{Footnotes are easy
with \LaTeX{}}.
```

... at the bottom of the page.

## 3.5.4 Comments

The `%` character is reserved for commenting. When used, the rest of the current line is ignored.

---

<sup>2</sup>Footnotes are easy with L<sup>A</sup>T<sub>E</sub>X!



## Creating your First L<sup>A</sup>T<sub>E</sub>X Document

---

*% This text will be ignored.*  
Some text *% will be ignored.*

Some text
-----------

If multiple lines need to be commented, highlight the necessary text and use the keyboard shortcut for commenting<sup>3</sup>.

Another way is to define a new command:

```
% Preamble
\newcommand{\comment}[1]{}
```

```
% Body
\comment{
You Can't See Me.
```

```
Just Like John Cena.
}
```

---

<sup>3</sup>Keyboard shortcuts for [Texmaker](#); [Texstudio](#).

# Chapter 4

## All About Text

### 4.1 Line Breaking

As mentioned previously, `\\` or `\newline` performs a line break. `\\*` starts a new line without starting a new paragraph.

Text is broken here. `\\*`  
The paragraph is not broken.

Text is broken here. The paragraph is not broken.
--

### 4.2 Page Breaking

`\newpage` should suffice.

### 4.3 Keeping Words Together

`\mbox` keeps words together in 1 line. No line breaks are allowed in the text.

These words are not grouped, but  
`\mbox{these words are}`.

These words are not grouped, but these words are.
--

`\fbox` draws a box around the grouped words.

`\fbox{These words are trapped}`.

These words are trapped.
--------------------------

### 4.4 Punctuation

#### 4.4.1 Apostrophes, Colons, Commas, Periods, and Semi-Colons

Simply type these punctuation marks. It is useful but not necessary to type `\frenchspacing` in the preamble. This tells the document to treat spacing after commas and periods equally.

#### 4.4.2 Dashes

There are 4 types of dashes:

```
hyphen (-): Pre-Christmas vibes. \\
en-dash (--): I work from 9--5. \\
em-dash (---): Yes --- or no? \\
minus sign ($-$): $-69$.
```

```
hyphen (-): Pre-Christmas vibes.
en-dash (--): I work from 9-5.
em-dash (—): Yes — or no?
minus sign (−): −69.
```

#### 4.4.3 Ellipsis

As it has better spacing and line-break behavior, `\ldots` in between dollar signs is a better solution than typing 3 dots.

```
3 dots: a b c... z \\
low dots: a b c $\ldots$ z
```

```
3 dots: a b c... z
low dots: a b c ... z
```

#### 4.4.4 Quotation Marks

The `dirtytalk` package is a comprehensive solution.

```
% Preamble
\usepackage{dirtytalk}

% Body
\say{I am surrounded!} \\
\say{Quotations can be \say{nested}
as well!}
```

```
"I am surrounded!"
"Quotations can be 'nested' as well!"
```

If you want to define the primary and secondary set of quotation marks, type the following in the preamble:

## All About Text

---

```
\usepackage[
  left = ``,%
  right = '',%
  leftsub = `,%
  rightsub = ',%
]{dirtytalk}
```

You can find a table of primary and secondary quotation marks in several languages [here](#).

### 4.4.5 Quotations

The quotation environment adds quotes to some text.

```
Walt Disney once said something
  interesting.
\begin{quotation}
The way to get started is to quit
  talking and begin doing.
\end{quotation}
It changed my life.
```

Walt Disney once said something interesting.

The way to get started is to quit talking and begin doing.

It changed my life.

## 4.5 More Special Characters

Commands for accents, diacritics, and other characters can be found on [Wikibooks](#). These commands may not be needed if the characters can be typed out from the keyboard.

## 4.6 Aligning Text

The `flushleft`, `center`, `flushright` environments align text to the left, center, and right, respectively.

## All About Text

---

```
\begin{flushleft}
Chairman Mao
\end{flushleft}

\begin{center}
Canada
\end{center}

\begin{flushright}
Hitler
\end{flushright}
```

Chairman Mao
Canada
Hitler

## 4.7 Coloring Text

Add color to the document using the `xcolor` package. Use `\textcolor` or `\color` to color text.

```
% Preamble
\usepackage{xcolor}

% Body
\textcolor{yellow}{Black} and
  {\color{black}yellow}.
```

Black and yellow.
-------------------

If you want to highlight text, then use `\colorbox`.

```
% Preamble
\usepackage{xcolor}

% Body
\colorbox{yellow}{Black} \\\
\colorbox{black}{\textcolor{yellow}{yellow}}
```

Black
yellow

The colors provided by `xcolor` can be found [here](#). If you scroll down on the webpage, there are instructions to define more colors and set the page color.

## 4.8 Fonts

### 4.8.1 Font Sizes

L<sup>A</sup>T<sub>E</sub>X commands for font sizes:

## All About Text

---

```
{\tiny tiny} \\
{\scriptsize scriptsize} \\
{\footnotesize footnotesize} \\
{\small small} \\
{\normalsize normalsize} \\
{\large large} \\
{\Large Large} \\
{\LARGE LARGE} \\
{\huge huge}
```

tiny  
scriptsize  
footnotesize  
small  
normalsize  
large  
Large  
LARGE  
huge

A more thorough tutorial on font sizes can be found at [latex-tutorial.com](http://latex-tutorial.com).

### 4.8.2 Font Styles

Text can be type-faced in different ways. Popular commands include:

```
\underline{Underlined text} \\
\emph{Emphasized text.} \\
\textbf{Bold text.} \\
\textit{Italicized text.} \\
\textsl{Slanted text.} \\
\textsc{Smallcaps text.} \\
\uppercase{upper.} \\
\lowercase{LOWER.}
```

Underlined text  
*Emphasized text.*  
**Bold text.**  
*Italicized text.*  
*Slanted text.*  
SMALLCAPS TEXT.  
UPPER.  
lower.

`\underline` does not break properly to the next line, so use the [ulem](#) package to resolve the issue. This package also allows for underline styling and strikethroughs.

Note that although `\emph`, `\textit`, and `\textsl` have the same effect here, they render different effects with other fonts.

### 4.8.3 Font Families

The default font on a  $\text{\LaTeX}$  document is Computer Modern, which is part of the serif family. The other 2 popular font families are sans serif and monospace.

#### Changing the Global Font Family

To change the default font family for the whole document to monospace, type the following in the preamble:

## All About Text

---

```
\renewcommand{\familydefault}{\ttdefault}
```

Replace `\ttdefault` with `\sfdefault` for sans serif. As serif is the default font family for a  $\text{\LaTeX}$  document, nothing needs to be done to use it. However, if needed, use `\rmdefault`.

### Temporarily Changing the Font Family

To use these font families temporarily, use the following commands:

```
\textrm{Serif text.} \\
\textsf{Sans Serif text.} \\
\texttt{Monospace text.}
```

Serif text. Sans Serif text. Monospace text.
--

## 4.9 More Fonts

To use other fonts, employ external packages.

### 4.9.1 Using Other Fonts Installed on your PC

#### Using the font globally

To use fonts installed on a local PC (e.g. Times New Roman), type the following in the preamble:

```
\usepackage{fontspec}
\setmainfont{Times New Roman}
```

Then, you must typeset the document using the  $\text{\XeLaTeX}$  or  $\text{\LuaLaTeX}$  compiler. The section between 2:52 to 3:16 of [this](#) video might help with the compilation.

#### Using the font temporarily

If you only need to use Times New Roman for some text, type:

```
\usepackage{fontspec}
\newfontfamily{\tnrm}{Times New
  Roman}
{\tnrm Times New Roman Text.}
```

Times New Roman Text.
-----------------------

## All About Text

---

`\tnrm` was my choice. It can be replaced with a command of your choice (just make sure it isn't already defined).

The user can download fonts for their PC at [dafont.com](http://dafont.com).

### 4.9.2 Using The $\text{\LaTeX}$ Font Catalogue

More fonts and their instructions-for-use can be found on [The  \$\text{\LaTeX}\$  Font Catalogue](#)<sup>1</sup>. For example, if you want to use Bookman<sup>2</sup> as the global font, type the following in the preamble:

```
\usepackage{bookman}
```

If you want to use Bookman only for some text:

```
Normal Text. \\
{\fontfamily{pbk}\selectfont Bookman
Text.}
```

Normal Text. Bookman Text.
-------------------------------

Notice the code `pbk`. You need to know this code to access the font. The codes for the most common fonts can be found at [Stack Exchange](#).

Sometimes the font does not appear. This is because it needs to be installed by  $\text{\LaTeX}$ . For more information, read [this](#) guide.

---

<sup>1</sup>If you are writing mathematical expressions, use fonts with math support.

<sup>2</sup>Popular fonts can be found [here](#).



# Chapter 5

## International Language Support

### 5.1 Using polyglossia

#### 5.1.1 Languages Requiring Font Definitions

##### Arabic

Use the polyglossia package with the X<sub>Y</sub>TeX compiler as follows:

```
% Preamble
\usepackage{polyglossia}
\setdefaultlanguage{english}
\setotherlanguage{arabic}
\newfontfamily{\arabicfont}[Script=Arabic]{Scheherazade}
```

`\arabicfont` is used to type Arabic: النص هذا عكس يمكن

You must download the [Scheherazade](#) font on your local PC. Other fonts that support Arabic can be found [here](#).

##### Bengali

Use the polyglossia package with the X<sub>Y</sub>TeX compiler as follows:

```
% Preamble
\usepackage{polyglossia}
\setdefaultlanguage{english}
\setotherlanguage{bengali}
\newfontfamily{\bengalifont}[Script=Bengali]{Kalpurush}
```

## International Language Support

---

`\bengalifont` is used to type Bengali: আমি বাংলা বলি না।

You must download the [Kalpurush](#) font on your local PC. Other fonts that support Bengali can be found [here](#).

### Greek

Use the `polyglossia` package with the  $\text{\LaTeX}$  compiler as follows:

```
% Preamble
\usepackage{polyglossia}
\setdefaultlanguage{english}
\setotherlanguage{greek}
\newfontfamily{\greekfont}[Script=Greek]{Linux Libertine}
```

`\greekfont` is used to type Greek: Θέλω να πάω στη Μύκονο.

You must download the [Linux Libertine](#) font on your local PC. Some other Greek fonts can be found [here](#).

### Hebrew

Use the `polyglossia` package with the  $\text{\LaTeX}$  compiler as follows:

```
% Preamble %
\usepackage{polyglossia}
\setdefaultlanguage{english}
\setotherlanguage{hebrew}
\newfontfamily{\hebrewfont}[Script=Hebrew]{IBM Plex Sans Hebrew}
```

`\hebrewfont` is used to type Hebrew: אינטליגנטים. אנשים אנחנו

You must download the [IBM Plex Sans Hebrew](#) font on your local PC. Other fonts that support Hebrew can be found [here](#).

### Hindi

Use the `polyglossia` package with the  $\text{\LaTeX}$  compiler as follows:

```
% Preamble
\usepackage{polyglossia}
\setdefaultlanguage{english}
```

## International Language Support

---

```
\setotherlanguage{hindi}  
\newfontfamily{\hindifont}[Script=Devanagari]{Lohit Devanagari}
```

`\hindifont` is used to type Hindi: विराट कोहली भगवान हैं।

You must download the [Lohit Devanagari](#) font on your local PC. Other fonts that support Hindi can be found [here](#).

### Thai

Use the polyglossia package with the Xe<sub>La</sub>TeX compiler as follows:

```
% Preamble  
\usepackage{polyglossia}  
\setdefaultlanguage{english}  
\setotherlanguage{thai}  
\newfontfamily\thaifont[Script=Thai]{Prompt}
```

`\thaifont` is used to type Thai: ฤมาารเป็นคนไทย

You must download the [Prompt](#) font on your local PC. Other fonts that support Thai can be found [here](#).

### Russian

Use the polyglossia package with the Xe<sub>La</sub>TeX compiler as follows:

```
% Preamble  
\usepackage{polyglossia}  
\setdefaultlanguage{english}  
\setotherlanguage{russian}  
\newfontfamily\russianfont[Script=Cyrillic]{Linux Libertine}
```

`\russianfont` is used to type Russian: Путин любит лошадей!

You must download the [Linux Libertine](#) font on your local PC. Some other Russian fonts can be found [here](#).

**If you set the default language as Russian, you can type it without `\russianfont`. However, you still need to define `\russianfont` using `\newfontfamily` in the preamble. The same applies to the other languages in [5.1.1](#).**

### 5.1.2 Some Other Languages

#### Spanish

Use the polyglossia package with the Xe<sub>La</sub>TeX compiler as follows:

```
% Preamble
\usepackage{polyglossia}
\setdefaultlanguage{spanish}
```

¡December 23, 2021 es mi cumpleaños!

```
% Body
¡\today{} es mi cumpleaños!
```

If you only need to use Spanish temporarily:

```
% Preamble
\usepackage{polyglossia}
\setdefaultlanguage{english}
\setotherlanguage{spanish}
```

I speak Spanish.  
23 de diciembre de 2021 es mi cumpleaños.

```
% Body
I speak Spanish. \\
\textspanish{\today{} es mi
  cumpleaños.}
```

#### French

If you also want to add French, make the following changes:

```
% Preamble
\usepackage{polyglossia}
\setdefaultlanguage{english}
\setotherlanguages{spanish, french}
```

I speak Spanish.  
23 de diciembre de 2021 es mi cumpleaños.  
Je parle aussi français.

```
% Body
I speak Spanish. \\
\textspanish{\today{} es mi
  cumpleaños.} \\
\textfrench{Je parle aussi français.}
```

#### German

You can simply replace french with german in the code above.

Read the polyglossia [documentation](#) for a full list of supported languages.

### 5.2 Languages Requiring Other Packages

#### Chinese

The most comprehensive solution is to use the `ctex` package.

```
% Preamble
\usepackage[UTF8]{ctex}
```

```
% Body
你好
```

你好

It is recommended to use the  $\text{\LaTeX}$  compiler.

#### Japanese

The `xeCJK` package<sup>1</sup> takes care of Japanese.

```
% Preamble
\usepackage{xeCJK}
```

```
% Body
日本の首都は東京です
```

日本の首都は東京です

You must use the  $\text{\LaTeX}$  compiler.

#### Helpful Resources

1. [Language Fonts](#) - a list of fonts that support different languages.
2. [Wikibooks](#) - a more comprehensive guide for typesetting different languages.
3. [Overleaf](#) - further reading.

---

<sup>1</sup>This package can also be used to typeset Chinese.

# Chapter 6

## Page Layout

### 6.1 Line Spacing

`\linespread` alters the space between lines. Type it in the preamble.

```
% Default Line Spacing
\linespread{1}
```

```
% One and a Half Line Spacing
\linespread{1.3}
```

```
% Double Line Spacing
\linespread{1.6}
```

`\setlength{\baselineskip}{1.6 \baselineskip}` temporarily alters the line spacing to double spacing:

```
{
\setlength{\baselineskip}{1.6
\baselineskip}
A double spaced paragraph is a
  paragraph with twice the space
  between lines. Wow, that's meta!
\par} $\$
```

This is a normal paragraph with  
normal spacing. Nothing special.

A double spaced paragraph is a paragraph  
with twice the space between lines. Wow,  
that's meta!

This is a normal paragraph with normal  
spacing. Nothing special.

`\par` ends a paragraph and is necessary<sup>1</sup>.

---

<sup>1</sup>You can also use an empty line.

## 6.2 Paragraphs

### 6.2.1 Paragraph Indentation

#### Temporary Indentation

Sometimes paragraphs are indented. `\noindent` cancels the indent. If you want to indent a non-indented paragraph, use `\indent`.

#### Permanent Indentation

`\setlength{\parindent}{4em}` globally sets paragraph indentation to 4em. If you don't want any indentation in the document, use `\setlength{\parindent}{0em}`. Place the commands in the preamble, preferably before `\tableofcontents`.

### 6.2.2 Paragraph Spacing

`\setlength{\parskip}{1em}` globally sets spacing between 2 paragraphs to 1em.

More information of units such as em can be found [here](#).

### 6.2.3 Paragraph Shape

Load the `shapepar` package. You can write paragraphs with cool shapes.

```
\heartpar{This paragraph is shaped as a
heart because \LaTeX{} is powerful.
There are many other shapes
available. Just go through the
documentation for
\texttt{shapepar}. There are
circles, squares, rectangles, and
shapes you can't imagine. This is
kind of cringe but oh well.}
```

This para- graph  
is shaped as a heart be-  
cause  $\text{\LaTeX}$  is powerful. There  
are many other shapes available.  
Just go through the documenta-  
tion for `shapepar`. There are cir-  
cles, squares, rectangles, and  
shapes you can't imagine.  
This is kind of cringe  
but oh well.  
♡

For more information, read the `shapepar` [documentation](#). For irregular shapes, read this [post](#).

More information on paragraph formatting can be found on [Overleaf](#).

### 6.3 Page Elements

All documents classes except book (refer to 3.2 on page 11) are one-sided. In one-sided documents, each page is identical. In two-sided documents, odd and even pages have different margins. To create a two-sided document, use the twoside option.

```
% Books are two-sided documents
\documentclass{book}
```

```
% Use the two-sided option for other document classes
\documentclass[twoside]{article}
```

More information on one/two-sided documents can be found [here](#).

#### 6.3.1 Headers & Footers

##### Basic Customization

Use \pagestyles in the preamble.

```
% No Header, No Footer
\pagestyles{empty}
```

```
% No Footer, Header contains page number and some information
\pagestyles{headings}
```

```
% No Footer, Header for one-sided document
\pagestyles{myheadings}
\markright{Name \hfill Date \hfill} % Name is placed on the left, Date is
placed in the center, page number on the right
```

```
% No Footer, Header for two-sided document
\pagestyles{myheadings}
\markboth{Hi}{Hello} % 'Hi' on even pages, 'Hello' on odd pages
```

##### Advanced Customization

Load the fancyhdr package and do the following:

```
% Preamble
\usepackage{fancyhdr}
\pagestyle{fancy} % Sets page style to fancy
\fancyhf{} % Clears the Header and Footer for customization
```

For a one-sided documents, use the following commands:



## Page Layout

---

```
% Preamble
\rhead{Right Side of Header}
\chead{Header Center}
\lhead{Left Side of Header}
\rfoot{Right Side of Footer}
\cfoot{Footer Center}
\lfoot{Left Side of Footer}
```

For two-sided documents:

```
% Preamble
\fancyhead[LE,RO]{Outer} % LE = Left Even; RO = Right Odd
\fancyhead[RE,LO]{Inner} % RE = Right Even; LO = Left Odd
\fancyfoot[CE,CO]{Center} % CE = Center Even; CO = Center Odd
\fancyfoot[LE,RO]{\thepage} % Prints the page number on the Footer center on
    even and odd pages
```

More commands include:

Description	Command
Page Number	<code>\thepage</code>
Chapter Number	<code>\thechapter</code>
Section Number	<code>\thesection</code>
Chapter Name	<code>\chaptername</code>
Current Chapter / Section Name & Number	<code>\leftmark</code>
Current Section / Subsection Name & Number	<code>\rightmark</code>

`fancyhdr` provides decorative lines for the header and footer. If you need to customize the lines, do the following:

```
% Preamble
\renewcommand{\headrulewidth}{2pt} % Header Line
\renewcommand{\footrulewidth}{2pt} % Footer Line
```

### 6.3.2 Page Numbers

Use `\pagenumbering`.

```
% Preamble
\pagenumbering{arabic}
```

The page numbers will be Arabic numerals. If you need lowercase (uppercase) Roman numerals, use `roman` (Roman) instead.

## Page Layout

---

`\setcounter{page}` allows you to control the page counter.

```
\chapter{First Chapter}
```

```
\setcounter{page}{3} % 3 is assigned to the current page
```

More information on page numbering can be found [here](#).

## 6.4 Page Margins

The geometry package allows you to change the margins.

```
% Preamble
```

```
\usepackage[margin=2in]{geometry}
```

I have also used it to create help sheets.

```
% Preamble
```

```
\documentclass{article}
```

```
\usepackage[margin=1cm, landscape]{geometry}
```

```
\usepackage{multicol}
```

```
% Body
```

```
\begin{multicols}{3}
```

```
\section{Section 1}
```

```
\section{Section 2}
```

```
\section{Section 3}
```

```
\section{Section 4}
```

```
\end{multicols}
```

### Helpful Resources

Frankly, I don't have much experience with page margins, so I direct you to the following resources.

1. [CTAN](#) - geometry package documentation.
2. [Overleaf](#) - an introduction to page size and margins.
3. [Wikibooks](#) - an advanced guide for page layout (page margins, page size, page background).

# Chapter 7

## Mathematics

This is where the heart of  $\text{\LaTeX}$  lies.

### 7.1 $\mathcal{A}\mathcal{M}\mathcal{S}$ - $\text{\LaTeX}$ packages

It is **strongly recommended** to load the packages in the  $\mathcal{A}\mathcal{M}\mathcal{S}$ - $\text{\LaTeX}$  bundle when typesetting math. Copy this into the document's preamble:

```
\usepackage{mathtools, amssymb, amsthm}
```

### 7.2 Math Mode

Math mode must be used when writing math. There are 2 modes: inline and display.

#### 7.2.1 Inline (Text)

Inserts math in between text. Requires:

- an opening  $\$$  and closing  $\$$ ;
- or an opening  $\backslash($  and closing  $\backslash)$ ;
- or a `math` environment.

## Mathematics

`$9+10=21$` is false. `\\`

`\(3^2 + 4^2 = 5^2\)` is true. `\\`

`\begin{math}`  
`\sin{x}=\pi` \text{ has no solutions.}  
`\end{math}`

$9 + 10 = 21$  is false.

$3^2 + 4^2 = 5^2$  is true.

$\sin x = \pi$  has no solutions.

`\text` inserts text in math mode. If not, this happens:

`\begin{math}`  
`\sin{x} = \pi` has no solutions.  
`\end{math}`

$\sin x = \pi$  has no solutions.

### 7.2.2 Display (unnumbered)

Displays math in its own line and is unnumbered. Requires:

- an opening `$$` and closing `$$`;
- or an opening `\[` and closing `\]`;
- or an `equation*` environment;
- or a `displaymath` environment.

The Pythagorean theorem:

`$$a^2+b^2=c^2$$`

This is equivalent to:

`\[a^2+b^2=c^2\]`

Environments also work:

`\begin{equation*}`  
`a^2+b^2=c^2`  
`\end{equation*}`

Another environment:

`\begin{displaymath}`  
`a^2+b^2=c^2`  
`\end{displaymath}`

The Pythagorean theorem:

$$a^2 + b^2 = c^2$$

This is equivalent to:

$$a^2 + b^2 = c^2$$

Environments also work:

$$a^2 + b^2 = c^2$$

Another environment:

$$a^2 + b^2 = c^2$$

## 7.2.3 Display (numbered)

Displays math in its own line and is automatically labelled. Requires:

- an equation environment.

```
A legend once said that
\begin{equation}
9+10=21
\end{equation}
```

<p>A legend once said that</p> $9 + 10 = 21 \quad (7.1)$
--

## 7.2.4 Math Mode Fonts

The text and math fonts in a  $\text{\LaTeX}$  document are independent. The default math font is Computer Modern. Math fonts compatible with  $\text{\LaTeX}$  are rare. Refer to the footnote in 4.9.2 for more information.

If you need to use math fonts temporarily,  $\text{\LaTeX}$  provides a few pre-defined commands:

Description	Command	Output
Default	<code>ABCabc123</code>	<i>ABCabc123</i>
Roman	<code>\mathrm{ABCabc123}</code>	ABCabc123
Bold	<code>\mathbf{ABCabc123}</code>	<b>ABCabc123</b>
Italics	<code>\mathit{ABCabc123}</code>	<i>ABCabc123</i>
Typewriter	<code>\mathtt{ABCabc123}</code>	ABCabc123
Fraktur	<code>\mathfrak{ABCabc123}</code>	$\mathfrak{ABCabc123}$
Blackboard Bold	<code>\mathbb{ABC}</code>	$\mathbb{ABC}$
Caligraphic	<code>\mathcal{ABC}</code>	$\mathcal{ABC}$

Note that `\mathbb` and `\mathcal` only work with capital letters.

## 7.2.5 Math Mode Spacing

$\text{\LaTeX}$  automatically spaces content in math mode. It ignores whitespace characters. If you want custom spacing, refer to this [table](#). Here are a few examples:

A diagram illustrating the sequence of numbers from 1 to 12, arranged in a staircase pattern. The numbers are grouped by their remainder modulo 3:

- Group 1 (Remainder 1):** 1, 4, 7, 10
- Group 2 (Remainder 2):** 2, 5, 8, 11
- Group 3 (Remainder 0):** 3, 6, 9, 12

The arrangement shows how the sequence progresses through these groups, with each group containing four numbers.

$^{14}_6\text{C}$
$^{14}_6\text{C}$

### 7.3.1 Labelling Equations

A legend once said that
$9 + 10 = 21$ (genius)

$$1 + 1 = 2 \quad (7.2)$$

This refers to (7.2).

A long sum:

$$91 = 1+2+3+4+5+6+7+8+9+10+11+12+13$$

The `multline` environment resolves this.

```
A long sum:
\begin{multline}
91=1+2+3+4+5 \\
+6+7+8+9+10 \\
+11+12+13
\end{multline}
```

A long sum:

$$\begin{aligned}
 91 &= 1 + 2 + 3 + 4 + 5 \\
 &\quad + 6 + 7 + 8 + 9 + 10 \\
 &\quad + 11 + 12 + 13 \quad (7.3)
 \end{aligned}$$

`multline*` removes the equation label.

## 7.3.3 Gathering Equations

The `multline` solution looks messy, so another solution is to gather equations. The `gather` environment brings equations together, centered.

```
Centered equations:
\begin{gather}
1+1=2 \\
xyz+x+y+z=w
\end{gather}
```

Centered equations:

$$1 + 1 = 2 \quad (7.4)$$

$$xyz + x + y + z = w \quad (7.5)$$

```
Centered (unnumbered) equations:
\begin{gather*}
1+1=2 \\
xyz+x+y+z=w
\end{gather*}
```

Centered (unnumbered) equations:

$$1 + 1 = 2$$

$$xyz + x + y + z = w$$

The gathered environment (**within display mode**) assigns 1 label to the gathered equations.

```
\begin{equation}
\begin{gathered}
1+1=2 \\
xyz+x+y+z=w
\end{gathered}
\end{equation}
```

$$\begin{aligned}
 1 + 1 &= 2 \\
 xyz + x + y + z &= w
 \end{aligned} \quad (7.6)$$

## 7.3.4 Aligning Equations

Another solution to long equations is to align equations on the relation symbol (`=`, `<`, etc.) using the `align` environment.

## Mathematics

---

Aligned equations:

```
\begin{align}
1+1=2 \\
xyz+x+y+z=w
\end{align}
```

Aligned equations:

$$1 + 1 = 2 \quad (7.7)$$

$$xyz + x + y + z = w \quad (7.8)$$

Aligned (unnumbered) simplification:

```
\begin{align*}
1+2+3+4&=1+2+7 \\
&=1+9 \\
&=10
\end{align*}
```

Aligned (unnumbered) simplification:

$$1 + 2 + 3 + 4 = 1 + 2 + 7$$

$$= 1 + 9$$

$$= 10$$

Add text using `&` and `\text`.

Simplifying  $1+2+3+4$ :

```
\begin{align*}
1+2+3+4&=1+2+7 \\
&=1+9 \quad \& \text{(as } 2+7=9\text{)} \\
&= 10
\end{align*}
```

Simplifying  $1 + 2 + 3 + 4$ :

$$1 + 2 + 3 + 4 = 1 + 2 + 7$$

$$= 1 + 9 \quad (\text{as } 2 + 7 = 9)$$

$$= 10$$

Some more equations:

Aligned (unnumbered) equations:

```
\begin{align*}
x&=y \quad \& \quad y&=z \\
z&=x \quad \& \quad y&=x \\
z&=y \quad \& \quad x&=z
\end{align*}
```

Aligned (unnumbered) equations:

$$x = y \quad y = z$$

$$z = x \quad y = x$$

$$z = y \quad x = z$$

The aligned environment (**within display mode**) assigns 1 label to the aligned equations.

```
\begin{equation}
\begin{aligned}
1+1=2 \\
xyz+x+y+z=w
\end{aligned}
\end{equation}
```

$$1 + 1 = 2 \quad (7.9)$$

$$xyz + x + y + z = w$$

You can also use `split` instead of `aligned`. Read more about the differences [here](#).



## 7.4 Math Environments

### 7.4.1 Theorems, Lemmas, Corollaries, Propositions, Definitions, Remarks, Examples, Exercises, Asides

These environments may be helpful when writing math. Define them in the preamble.

```
\newtheoremstyle{dotless}{0}{0}{0}{0}{\bfseries}{0}{12pt}{0}
\theoremstyle{dotless}
\newtheorem{thm}{Theorem}[section] % Theorem
\newtheorem*{thm*}{Theorem} % Theorem (unnumbered)
\newtheorem{lem}[thm]{Lemma} % Lemma
\newtheorem*{lem*}{Lemma} % Lemma (unnumbered)
\newtheorem{cor}[thm]{Corollary} % Corollary
\newtheorem*{cor*}{Corollary} % Corollary (unnumbered)
\newtheorem{prop}[thm]{Proposition} % Proposition
\newtheorem*{prop*}{Proposition} % Proposition (unnumbered)
\newtheorem{defn}[thm]{Definition} % Definition
\newtheorem*{defn*}{Definition} % Definition (unnumbered)
\newtheorem{rem}[thm]{Remark} % Remark
\newtheorem*{rem*}{Remark} % Remark (unnumbered)
\newtheorem{exa}[thm]{Example} % Example
\newtheorem*{exa*}{Example} % Example (unnumbered)
\newtheorem{exe}[thm]{Exercise} % Exercise
\newtheorem*{exe*}{Exercise} % Exercise (unnumbered)
\newtheorem{aside}[thm]{Aside} % Aside
\newtheorem*{aside*}{Aside} % Aside (unnumbered)
```

Implementing:

```
% Theorem
\begin{thm}
This is a theorem.
\end{thm}
```

```
% Example
\begin{exa}
 $1+1=2$ 
\end{exa}
```

```
% Exercise (unnumbered)
\begin{exe*}
Does  $2+2=4$ ?
\end{exe*}
```

**Theorem 7.4.1** This is a theorem.

**Example 7.4.2**  $1 + 1 = 2$

**Exercise** Does  $2 + 2 = 4$ ?

## 7.4.2 Proofs

The proof environment is provided by the `mathtools` package.

```
\begin{proof}
$1+1=2 \implies 1=1$
\end{proof}
```

*Proof.*  $1 + 1 = 2 \implies 1 = 1$  □

Changing the QED symbol:

```
% Preamble
\renewcommand\qedsymbol{$\blacksquare$}
```

```
% Body
\begin{proof}
$1+1=2 \implies 1=1$
\end{proof}
```

*Proof.*  $1 + 1 = 2 \implies 1 = 1$  ■

Changing the QED symbol (again):

```
% Preamble
\renewcommand\qedsymbol{QED}
```

```
% Body
\begin{proof}
$1+1=2 \implies 1 = 1$
\end{proof}
```

*Proof.*  $1 + 1 = 2 \implies 1 = 1$  QED

You can also change the style of the proof environment.

```
% Preamble
\renewenvironment{proof}{\bfseries
Proof.}{\hfill$\square$}
```

```
% Body
\begin{proof}
$1+1=2 \implies 1 = 1$
\end{proof}
```

**Proof.**  $1 + 1 = 2 \implies 1 = 1$  □

Unlike the environments in 7.3, math mode must be used in the environments mentioned in 7.4.1 and 7.4.2.

## 7.5 Numbers

### 7.5.1 Reals ( $\mathbb{R}$ )

#### Integers ( $\mathbb{Z}$ )

Type out the integers. The font changes in math mode.

$-1, 0, 2, 4$  `\%` *math mode font*  
 $-1, 0, 2, 4$  `\%` *text mode font*

$-1, 0, 2, 4$   
 $-1, 0, 2, 4$

#### Rationals ( $\mathbb{Q}$ )

`\frac` is used.

$\frac{1}{2}$  `\%`  
 $\frac{\frac{1}{2} + \frac{1}{2}}{1+2}$   
 $\frac{7}{10}$

$\frac{1}{2}$   
 $\frac{\frac{1}{2} + \frac{1}{2}}{1+2}$   
 $\frac{7}{10}$

Use `\dfrac` for a **d**isplay mode sized fraction and `\tfrac` for a **t**ext mode sized fraction.

$\dfrac{69}{420}$   
 $\tfrac{1}{1000}$

$\dfrac{69}{420}$   
 $\tfrac{1}{1000}$

You can also use `\frac{1}{2}` to display  $\frac{1}{2}$ .

#### Irrationals( $\mathbb{I}$ )

A few famous irrationals:

Description	Command	Output
Pi	<code>\pi</code>	$\pi$
Euler's Number	<code>e, \mathrm{e}</code>	$e, e$
Logarithms	<code>\log_{2}{3}</code>	$\log_2 3$
Golden Ratio	<code>\phi</code>	$\phi$
Unit Square Diagonal	<code>\sqrt{2}</code>	$\sqrt{2}$

The area of a unit circle is  $\pi$ .

The area of a unit circle is  $\pi$ .

## Mathematics

### 7.5.2 Complex Numbers ( $\mathbb{C}$ )

Imaginary Unit:  $i$ ,  $\mathrm{i}$

Imaginary Unit:  $i, i$

Complex number:  $z=2+2i$

Complex number:  $z = 2 + 2i$

Conjugate:  $z^*=2-2i$

Conjugate:  $z^* = 2 - 2i$

Real Part:  $\Re(z)=2$  or  
 $\mathrm{Re}(z)=2$

Real Part:  $\Re(z) = 2$  or  $\mathrm{Re}(z) = 2$

Imaginary Part:  $\Im(z)=2$  or  
 $\mathrm{Im}(z)=2$

Imaginary Part:  $\Im(z) = 2$  or  $\mathrm{Im}(z) = 2$

Absolute Value:  $|z|=2\sqrt{2}$

Absolute Value:  $|z| = 2\sqrt{2}$

Argument:  $\arg(z)=\frac{\pi}{2}$

Argument:  $\arg(z) = \frac{\pi}{2}$

### 7.6 Variables

Variables are letters in math mode.

Find x vs. Find  $x$

Find x vs. Find  $x$

*% Text Mode*

abcdefghijklmnopqrstuvwxyz

abcdefghijklmnopqrstuvwxyz

*% Math Mode*

$abcdefghijklmnopqrstuvwxyz$

$abcdefghijklmnopqrstuvwxyz$

The solution to  $ax^2+bx+c=0$  is  
$$x=\frac{-b \pm \sqrt{b^2-4ac}}{2a}.$$

The solution to  $ax^2 + bx + c = 0$  is

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

# Mathematics

## 7.6.1 Greek & Hebrew Letters

Command	Output	Command	Output	Command	Output	Command	Output
<code>\alpha</code>	$\alpha$	<code>\mu</code>	$\mu$	<code>\upsilon</code>	$\upsilon$	<code>\Upsilon</code>	$\Upsilon$
<code>\beta</code>	$\beta$	<code>\nu</code>	$\nu$	<code>\xi</code>	$\xi$	<code>\aleph</code>	$\aleph$
<code>\chi</code>	$\chi$	<code>\omega</code>	$\omega$	<code>\zeta</code>	$\zeta$	<code>\beth</code>	$\beth$
<code>\delta</code>	$\delta$	<code>\phi</code>	$\phi$	<code>\Delta</code>	$\Delta$	<code>\daleth</code>	$\daleth$
<code>\epsilon</code>	$\epsilon$	<code>\varphi</code>	$\varphi$	<code>\Gamma</code>	$\Gamma$	<code>\gimel</code>	$\gimel$
<code>\varepsilon</code>	$\varepsilon$	<code>\pi</code>	$\pi$	<code>\Lambda</code>	$\Lambda$		
<code>\eta</code>	$\eta$	<code>\psi</code>	$\psi$	<code>\Omega</code>	$\Omega$		
<code>\gamma</code>	$\gamma$	<code>\rho</code>	$\rho$	<code>\Phi</code>	$\Phi$		
<code>\iota</code>	$\iota$	<code>\sigma</code>	$\sigma$	<code>\Psi</code>	$\Psi$		
<code>\kappa</code>	$\kappa$	<code>\tau</code>	$\tau$	<code>\Sigma</code>	$\Sigma$		
<code>\lambda</code>	$\lambda$	<code>\theta</code>	$\theta$	<code>\Theta</code>	$\Theta$		

The cardinality of the natural numbers is `\aleph_0`.

The cardinality of the natural numbers is  $\aleph_0$ .

More Greek symbols can be found [here](#).

## 7.7 Math Symbols

In this section, I will list some basic math symbols. However, if you need to find commands for symbols that are not included here, refer to 3.4.5 on page 13.

### 7.7.1 Basic Arithmetic

Description	Command	Output
Addition	<code>+</code>	$+$
Subtraction	<code>-</code>	$-$
Multiplication (times)	<code>\times</code>	$\times$
Multiplication (dot)	<code>\cdot</code>	$\cdot$
Division (sign)	<code>\div</code>	$\div$
Division (slash)	<code>/</code>	$/$
Exponentiation	<code>a^{b}</code>	$a^b$

`3 \times ((3^3 \div 3) \div 3) + (((3+3)/3) + 3 - 3 + 3 + 3) = 69`

$3 \times ((3^3 \div 3) \div 3) + (((3+3)/3) + 3 - 3 + 3 + 3) = 69$

## 7.7.2 Basic Algebra

Description	Command	Output
Plus-Minus	<code>\pm</code>	$\pm$
Minus-Plus	<code>\mp</code>	$\mp$
Square Root	<code>\sqrt{x}</code>	$\sqrt{x}$
$n^{\text{th}}$ Root	<code>\sqrt[n]{x}</code>	$\sqrt[n]{x}$
Absolute Value	<code> x </code>	$ x $
Natural Log	<code>\ln{x}</code> , <code>\ln(x+y)</code>	$\ln x$ , $\ln(x+y)$
Log	<code>\log_{2}{3}</code> , <code>\log_{2}(3+1)</code>	$\log_2(3+1)$
Factorial	<code>5!</code>	$5!$

```

\sqrt{\sqrt{81}}=3$ \
\sqrt[2]{9}=3$ \
\sqrt[3]{27}=3$ \
|3|=3$ \
\ln{3}=\log_{e}{3}$ \
\ln(3)=\log_{e}(3)$

```

$$\begin{aligned}\sqrt{\sqrt{81}} &= 3 \\ \sqrt[2]{9} &= 3 \\ \sqrt[3]{27} &= 3 \\ |3| &= 3 \\ \ln 3 &= \log_e 3 \\ \ln(3) &= \log_e(3)\end{aligned}$$

More operator symbols can be found [here](#).

### polynom package

You can divide and factorize polynomials with the polynom package.

```

% Long Division
\polylongdiv{x^3+x^2+x+1}{x+1}$

```

$$\begin{array}{r} x^2 \quad + 1 \\ x+1 \overline{) x^3 + x^2 + x + 1} \\ \underline{-x^3 - x^2} \phantom{+ 1} \\ x + 1 \\ \underline{-x - 1} \\ 0 \end{array}$$

```

% Factorization
$x^5+x^4+x^3+x^2+x+1 = $
$$\polyfactorize{
x^5+x^4+x^3+x^2+x+1
}$

```

$$\begin{aligned}x^5 + x^4 + x^3 + x^2 + x + 1 &= \\ (x^4 + x^2 + 1)(x + 1)\end{aligned}$$

## cancel package

You can cancel fractions with the cancel package.

```


$$\frac{3 \cdot \cancel{2}}{\cancel{2} \cdot 4} = \frac{3}{4}$$


```

$$\frac{3 \cdot \cancel{2}}{\cancel{2} \cdot 4} = \frac{3}{4}$$

## 7.7.3 Comparison Symbols

Description	Command	Output
Equal to	=	=
Approximately Equal to	\approx	$\approx$
Not Equal to	\neq	$\neq$
Less Than	<	<
Less Than or Equal to	\leq	$\leq$
Less Than or Equal to (slant)	\leqslant	$\leqslant$
Much Less Than	\ll	$\ll$
Greater Than	>	>
Greater Than or Equal to	\geq	$\geq$
Greater Than or Equal to (slant)	\geqslant	$\geqslant$
Much Greater Than	\gg	$\gg$
Proportional To	\propto	$\propto$

$\pi \approx 3.14$ , but  $\pi \neq 3.14$  and  $\pi \geq 3.14$ . In other words,  $\pi > 3.14$ .

$\pi \approx 3.14$ , but  $\pi \neq 3.14$  and  $\pi \geq 3.14$ . In other words,  $\pi > 3.14$ .

More Comparison symbols can be found [here](#).

## 7.7.4 Subscripts

Description	Command	Output
Superscript	a <sup>{b}</sup>	$a^b$
Subscript	a <sub>{0}</sub>	$a_0$

<sup>^</sup> and <sub>\_</sub> only impact the next character, so it's better to group the necessary characters with {}.

Examples with {}<sup>1</sup>:

---

<sup>1</sup> $x^2^3$  and  $x_{2_3}$  yield errors.

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`$x^{2} \quad x_{2}$ \\`  
`$x^{10} \quad x_{10}$ \\`  
`$x^{y^{2}} \quad x_{y_{2}}$ \\`  
`$x^{y_{2}} \quad x_{y^{2}}$`

$x^2$	$x_2$
$x^{10}$	$x_{10}$
$x^{y^2}$	$x_{y_2}$
$x^{y_2}$	$x_{y^2}$

Examples without `{}`:

`$x^2 \quad x_2$ \\`  
`$x^2z^3 \quad x_2z_3$ \\`  
`$x^2z^3 \quad x_2z_2$ \\`  
`$x^{10} \quad x_{10}$`

$x^2$	$x_2$
$x^2z^3$	$x_2z_3$
$x^2z^3$	$x_2z_2$
$x^{10}$	$x_{10}$

Mixing things up:

`$x^{420}_{69} - y \quad x_{69}^{420}$ \\`  
`- y$ \\`  
`${}^{14}_{6}C \quad {}_{6}^{14}C$ \\`  
`${}^1_1H \quad {}_1^1H$ \\`  
`$A_1^2 \quad A_1^2$ \\`  
`$A_1^2 \quad A_1^2$ \\`  
`${}^2_2B \quad {}_2A_1$ \\`  
`$x_1' \quad x_2'$`

$x_{69}^{420}$	$-y$	$x_{69}^{420}$	$-y$
${}^{14}_6C$		${}^{14}_6C$	
${}_1^1H$		${}_1^1H$	
$A_1^2$		$A_1^2$	
$A_1^2$		$A_1^2$	
${}_2^2B$		${}_2A_1$	
$x_1'$		$x_2'$	

### 7.7.5 Fences (Delimiters)

Description	Command	Output
Round Brackets	<code>(x)</code>	$(x)$
Square Brackets	<code>[x]</code>	$[x]$
Curly Brackets	<code>\{x\}</code>	$\{x\}$
Angled Brackets	<code>\langle x \rangle</code>	$\langle x \rangle$
Floor	<code>\lfloor x \rfloor</code>	$\lfloor x \rfloor$
Ceiling	<code>\lceil x \rceil</code>	$\lceil x \rceil$
Norm	<code>\ x\ </code>	$\ x\ $
Upper Corners	<code>\ulcorner x \urcorner</code>	$\ulcorner x \urcorner$
Lower Corners	<code>\llcorner x \lrcorner</code>	$\llcorner x \lrcorner$

If the fences are too small, use `\left` and `\right` before the left and right fence, respectively.



## Mathematics

---

`$$n \to \infty \implies \left(1 + \frac{1}{n}\right)^n \to e$$`

$$n \rightarrow \infty \implies \left(1 + \frac{1}{n}\right)^n \rightarrow e$$

For bigger, custom fence sizes, use `\big`, `\Big`, `\bigg`, or `\Bigg` before both the left and right fence.

### 7.7.6 Dots

Description	Command	Output
Comma Separated List	<code>1, 2, \dotsc, 5</code>	$1, 2, \dots, 5$
Lower Dots	<code>1, 2, \ldots, 5</code>	$1, 2, \dots, 5$
Multiplication Dots	<code>1 \cdot 2 \cdot 3 \dotsm 5</code>	$1 \cdot 2 \cdot 3 \cdots 5$
Binary Operation Dots	<code>1 + 2 + \dotsb + 5</code>	$1 + 2 + \cdots + 5$
Other Dots	<code>1, 2, \dotso, 5</code>	$1, 2, \dots, 5$
Vertical Dots	<code>\vdots</code>	$\vdots$
Diagonal Dots	<code>\ddots</code>	$\ddots$

## 7.7.7 Arrows

Description	Command	Output
Right Arrow	<code>\to, \rightarrow</code>	$\rightarrow$
Long Right Arrow	<code>\longrightarrow</code>	$\longrightarrow$
Not Right Arrow	<code>\nrightarrow</code>	$\nrightarrow$
Thick Right Arrow	<code>\Rightarrow</code>	$\Rightarrow$
Thick Long Right Arrow	<code>\Longrightarrow</code>	$\Longrightarrow$
Thick Not Right Arrow	<code>\nRightarrow</code>	$\nRightarrow$
Left Arrow	<code>\leftarrow, \gets</code>	$\leftarrow$
Long Left Arrow	<code>\longleftarrow</code>	$\longleftarrow$
Not Left Arrow	<code>\nleftarrow</code>	$\nleftarrow$
Thick Left Arrow	<code>\Leftarrow</code>	$\Leftarrow$
Thick Long Left Arrow	<code>\Longleftarrow</code>	$\Longleftarrow$
Thick Not Left Arrow	<code>\nLeftarrow</code>	$\nLeftarrow$
Left-Right Arrow	<code>\leftrightarrow</code>	$\leftrightarrow$
Not Left-Right Arrow	<code>\nleftrightarrow</code>	$\nleftrightarrow$
Thick Left-Right Arrow	<code>\iff</code>	$\iff$
Up Arrow	<code>\uparrow</code>	$\uparrow$
Thick Up Arrow	<code>\Uparrow</code>	$\Uparrow$
Down Arrow	<code>\downarrow</code>	$\downarrow$
Thick Down Arrow	<code>\Downarrow</code>	$\Downarrow$
Up-Down Arrow	<code>\updownarrow</code>	$\updownarrow$
Thick Up-Down Arrow	<code>\Updownarrow</code>	$\Updownarrow$
Maps To	<code>\mapsto</code>	$\mapsto$
Maps To (Long)	<code>\longmapsto</code>	$\longmapsto$
Leads To	<code>\leadsto</code>	$\leadsto$

## 7.7.8 Decorations

Description	Command	Output
Over-brace	<code>\overbrace{x+y}^{=y+x}</code>	$\overbrace{x+y}^{=y+x}$
Prime	<code>f'</code>	$f'$
Prime Prime	<code>f''</code>	$f''$
Dot	<code>\dot{x}</code>	$\dot{x}$
Dot Dot	<code>\ddot{x}</code>	$\ddot{x}$
Hat	<code>\hat{x}</code>	$\hat{x}$
Wide Hat	<code>\widehat{x+y}</code>	$\widehat{x+y}$
Tilde	<code>\tilde{x}</code>	$\tilde{x}$
Wide Tilde	<code>\widetilde{x+y}</code>	$\widetilde{x+y}$
Bar	<code>\bar{x}</code>	$\bar{x}$
Under-brace	<code>\underbrace{x+y}_{=y+x}</code>	$\underbrace{x+y}_{=y+x}$

## 7.7.9 Miscellaneous

Description	Command	Output
Asterisk	<code>\ast</code>	$*$
Bow Tie	<code>\bowtie</code>	$\bowtie$
Bullet	<code>\bullet</code>	$\bullet$
Dagger	<code>\dagger</code>	$\dagger$
Curly l	<code>\ell</code>	$\ell$
Star	<code>\star</code>	$\star$
Surd	<code>\surd</code>	$\surd$
Tick	<code>\checkmark</code>	$\checkmark$
Tilde	<code>\sim</code>	$\sim$

## 7.8 Set Theory

## 7.8.1 Number Sets

Description	Command	Output
Boolean Numbers	<code>\mathbb{B}</code>	$\mathbb{B}$
Prime Numbers	<code>\mathbb{P}</code>	$\mathbb{P}$
Natural Numbers	<code>\mathbb{N}</code>	$\mathbb{N}$
Whole Numbers	<code>\mathbb{W}</code>	$\mathbb{W}$
Integers	<code>\mathbb{Z}</code>	$\mathbb{Z}$
Rationals	<code>\mathbb{Q}</code>	$\mathbb{Q}$
Algebraic Numbers	<code>\mathbb{A}</code>	$\mathbb{A}$
Irrationals	<code>\mathbb{I}</code>	$\mathbb{I}$
Reals	<code>\mathbb{R}</code>	$\mathbb{R}$
Complex Numbers	<code>\mathbb{C}</code>	$\mathbb{C}$
Quaternions	<code>\mathbb{H}</code>	$\mathbb{H}$
Octonions	<code>\mathbb{O}</code>	$\mathbb{O}$
Sedenions	<code>\mathbb{S}</code>	$\mathbb{S}$
Empty Set	<code>\emptyset</code> , <code>\varnothing</code>	$\emptyset$ , $\varnothing$
Power Set	<code>\mathcal{P}</code>	$\mathcal{P}$

## 7.8.2 Set Notation

Description	Command	Output
Brackets	<code>\{3, 1, 4\}</code>	$\{3, 1, 4\}$
Cardinality	<code>\mathbf{card}(S),  S </code>	$\mathbf{card}(S),  S $
Definition	<code>A:=B</code>	$A := B$
Element of	<code>\in</code>	$\in$
Not an Element of	<code>\notin</code>	$\notin$
Subset of	<code>\subset</code>	$\subset$
Subset of	<code>\subseteq</code>	$\subseteq$
Subset of but Not Equal to	<code>\subsetneq</code>	$\subsetneq$
Not a Subset of	<code>\not\subset</code>	$\not\subset$
Not a Subset of	<code>\nsubseteq</code>	$\nsubseteq$
Contains	<code>\supset</code>	$\supset$
Contains	<code>\supseteq</code>	$\supseteq$
Union	<code>\cup</code>	$\cup$
Big Union	<code>\bigcup_{n=1}^{10}\{A_n\}</code>	$\bigcup_{n=1}^{10} A_n$
Disjoint Union	<code>\sqcup</code>	$\sqcup$
Intersection	<code>\cap</code>	$\cap$
Big Intersection	<code>\bigcap_{n=1}^{10}\{A_n\}</code>	$\bigcap_{n=1}^{10} A_n$
Set Difference	<code>\setminus</code>	$\setminus$
Symmetric Difference	<code>\triangle</code>	$\triangle$
Set Complement	<code>A^{\mathsf{c}}</code>	$A^c$
Set Complement	<code>\overline{A}</code>	$\overline{A}$
Cartesian Product	<code>\times</code>	$\times$

## 7.8.3 braket package

You can load the `braket` package when typesetting sets.

*% Preamble*

```
\usepackage{braket}
```

*% Body*

```
$$ \Set{x \in \mathbb{R} \mid 0 < x < \frac{1}{3}} $$
```

$$\left\{ x \in \mathbb{R} \mid 0 < x < \frac{1}{3} \right\}$$

## 7.9 Logic

Description	Command	Output
Not	<code>\neg</code> , <code>\sim</code>	$\neg$ , $\sim$
And	<code>\land</code>	$\wedge$
Or	<code>\lor</code>	$\vee$
Exclusive Or (XOR)	<code>\oplus</code>	$\oplus$
If... Then	<code>\implies</code> , <code>\Longrightarrow</code>	$\implies$
Only If	<code>\Longleftarrow</code>	$\Longleftarrow$
If and Only If	<code>\iff</code>	$\iff$
Equivalence	<code>\equiv</code>	$\equiv$
Therefore	<code>\therefore</code>	$\therefore$
Because	<code>\because</code>	$\because$
Exists	<code>\exists</code>	$\exists$
Exists Uniquely	<code>\exists!</code>	$\exists!$
There is No	<code>\nexists</code>	$\nexists$
For All	<code>\forall</code>	$\forall$
Top	<code>\top</code>	$\top$
Bottom	<code>\bot</code>	$\bot$

More logic symbols can be found on [Wikipedia](#).

## 7.10 Algebra

### 7.10.1 Infinity

First, you ought to know the commands for  $\infty$  and  $-\infty$ .

Description	Command	Output
Infinity	<code>\infty</code>	$\infty$
Negative Infinity	<code>-\infty</code>	$-\infty$

### 7.10.2 Intervals

There are 9 types of intervals:

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Description	Command	Output
Finite Open	<code>(a, b)</code>	$(a, b)$
Finite Closed	<code>[a, b]</code>	$[a, b]$
Finite Half Closed - Half Open	<code>[a, b)</code>	$[a, b)$
Infinite Half Closed - Half Open	<code>[a, \infty)</code>	$[a, \infty)$
Infinite Half Open - Half Closed	<code>(-\infty, b]</code>	$(-\infty, b]$
Infinite Open	<code>(a, \infty)</code>	$(a, \infty)$
Infinite Open	<code>(-\infty, b)</code>	$(-\infty, b)$
Reals	<code>(\infty, -\infty)</code>	$(\infty, -\infty)$

### 7.10.3 Functions

Description	Command	Output
Colon	<code>\colon</code>	$:$
Function	<code>\to, \rightarrow</code>	$\rightarrow$
Maps To	<code>\mapsto</code>	$\mapsto$
Injection	<code>\rightarrowtail</code>	$\rightarrowtail$
Injection	<code>\hookrightarrow</code>	$\hookrightarrow$
Injection	<code>\xrightarrow{\tiny 1:1}</code>	$\xrightarrow{1:1}$
Injection	<code>\xrightarrow[\tiny 1:1]{}</code>	$\xrightarrow[\tiny 1:1]{}$
Surjection	<code>\twoheadrightarrow</code>	$\twoheadrightarrow$
Surjection	<code>\xrightarrow{\tiny \text{onto}}</code>	$\xrightarrow{\text{onto}}$
Bijection	<code>\xrightarrow{\tiny 1:1, \text{ onto}}</code>	$\xrightarrow{1:1, \text{ onto}}$
Bijection	<code>\xrightarrow{\tiny \text{bij}}</code>	$\xrightarrow{\text{bij}}$
Composition	<code>\circ</code>	$\circ$
Restriction	<code>f _{X}</code>	$f _X$
Inverse	<code>f^{-1}</code>	$f^{-1}$
Convolution	<code>\ast</code>	$*$
Fourier Transform	<code>\hat{f}</code>	$\hat{f}$

While you could type out “:”, `\colon` allows for proper spacing.

```
% :
$f \circ g: [0, 1] \to [0, 1]$ is a
  function. \\

% \colon
$f \circ g \circ h \colon A \to B$
  is a function.
```

$$f \circ g : [0, 1] \rightarrow [0, 1] \text{ is a function.}$$

$$f \circ g \circ h : A \rightarrow B \text{ is a function.}$$

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Use the cases environment to define a piecewise function.

```


$$f(x) = 1_{\mathbb{Q}}(x) =$$


$$\begin{cases} 1 & x \in \mathbb{Q} \\ 0 & x \notin \mathbb{Q} \end{cases}$$


```

$$f(x) = 1_{\mathbb{Q}}(x) = \begin{cases} 1 & x \in \mathbb{Q} \\ 0 & x \notin \mathbb{Q} \end{cases}$$

If you need to include text, then:

```


$$f(x) = 1_{\mathbb{Q}}(x) =$$


$$\begin{cases} 1 & \text{if } x \in \mathbb{Q} \\ 0 & \text{if } x \notin \mathbb{Q} \end{cases}$$


```

$$f(x) = 1_{\mathbb{Q}}(x) = \begin{cases} 1 & \text{if } x \in \mathbb{Q} \\ 0 & \text{if } x \notin \mathbb{Q} \end{cases}$$

## 7.11 Geometry

### 7.11.1 Geometry Notation

Description	Command	Output
Line Segment	<code>\overline{AB}</code>	$\overline{AB}$
Ray	<code>\overrightarrow{AB}</code>	$\overrightarrow{AB}$
Line	<code>\leftrightarrow{AB}</code>	$\leftrightarrow{AB}$
Triangle	<code>\triangle{ABC}</code>	$\triangle ABC$
Square	<code>\square{ABC}</code>	$\square ABC$
Angle	<code>\angle{ABC}</code>	$\angle ABC$
Measured Angle	<code>\measuredangle{ABC}</code>	$\measuredangle ABC$
Degrees	<code>180^\circ</code>	$180^\circ$
Congruent	<code>\cong</code>	$\cong$
Not Congruent	<code>\ncong</code>	$\ncong$
Similar	<code>\sim</code>	$\sim$
Not Similar	<code>\nsim</code>	$\nsim$
Parallel	<code>\parallel</code>	$\parallel$
Not Parallel	<code>\nparallel</code>	$\nparallel$
Perpendicular	<code>\perp</code>	$\perp$
Not Perpendicular	<code>\not\perp</code>	$\not\perp$



## 7.11.2 Trigonometry & Hyperbolic Functions

Description	Command	Output
Sine	<code>\sin{\pi}, \sin(\pi)</code>	$\sin \pi, \sin(\pi)$
Cosine	<code>\cos{\pi}</code>	$\cos \pi$
Tangent	<code>\tan{\pi}</code>	$\tan \pi$
Cosecant	<code>\csc{\pi}</code>	$\csc \pi$
Secant	<code>\sec{\pi}</code>	$\sec \pi$
Cotangent	<code>\cot{\pi}</code>	$\cot \pi$
Inverse Sine	<code>\arcsin{0}</code>	$\arcsin 0$
Inverse Cosine	<code>\arccos{0}</code>	$\arccos 0$
Inverse Tangent	<code>\arctan{0}</code>	$\arctan 0$
Hyperbolic Sine	<code>\sinh{0}</code>	$\sinh 0$
Hyperbolic Cosine	<code>\cosh{0}</code>	$\cosh 0$
Hyperbolic Tangent	<code>\tanh{0}</code>	$\tanh 0$

## 7.11.3 Sums

Sums are different in inline and display mode.

The harmonic series  
`\sum_{n=1}^{\infty}{\frac{1}{n}}`  
 is divergent. `\`

The harmonic series  
`$$\sum_{n=1}^{\infty}{\frac{1}{n}}$$`  
 is divergent.

The harmonic series  $\sum_{n=1}^{\infty} \frac{1}{n}$  is divergent.

The harmonic series

$$\sum_{n=1}^{\infty} \frac{1}{n}$$

is divergent.

While the curly braces `{}` are not necessary, they make the code readable.

`$$\sum_a^b \frac{1}{n}$$`

$$\sum_a^b \frac{1}{n}$$

You can also typeset double sums.

`$$\sum_{i=1}^2{\sum_{j=1}^2{i+j}}`  
`= 12$$`

$$\sum_{i=1}^2 \sum_{j=1}^2 i + j = 12$$

Use `\substack` to write the limits over multiple lines.

```


$$\sum_{\substack{0 \leq i \leq 2 \\ 0 \leq j \leq 2}} i + j = 12$$


```

$$\sum_{\substack{0 \leq i \leq 2 \\ 0 \leq j \leq 2}} i + j = 12$$

You can forcefully change the position of the limits for sums using `\limits` and `\nolimits`<sup>2</sup>.

```

% Inline Mode
 $\sum_{n=1}^5 n$ 

% Inline Mode (placing limit
  position under sum)
 $\sum\limits_{n=1}^5 n$ 

% Inline Mode (placing limit
  position besides sum)
 $\sum\nolimits_{n=1}^5 n$ 

% Display Mode

$$\sum_{n=1}^5 n$$


% Display Mode (placing limit
  position under sum)

$$\sum\limits_{n=1}^5 n$$


% Display Mode (placing limit
  position besides sum)

$$\sum\nolimits_{n=1}^5 n$$


```

$$\begin{array}{c} \sum_{n=1}^5 n \\ \sum\limits_{n=1}^5 n \\ \sum\nolimits_{n=1}^5 n \end{array}$$

## 7.11.4 Products

Refer to 7.11.3 on page 56 and replace sum with prod.

<sup>2</sup>This also applies for products, integrals, and limits.

```
% Inline Mode
$\prod_{n=1}^{50}\{n\}=50!\$ \\\

% Display Mode
The product $$\prod_{n=1}^{50}\{n\}$$
$=50!\$
```

$$\prod_{n=1}^{50} n = 50!$$

The product

$$\prod_{n=1}^{50} n$$

$$= 50!$$

## 7.12 Calculus

### 7.12.1 Derivatives

You can write a derivative as follows:

```
% Leibniz Notation
If $f(x)=x^2$, then
$$\frac{df}{dx}=2x.$$

% Lagrange Notation
Using other notation:
$$f'(x)=2x$$
```

If  $f(x) = x^2$ , then

$$\frac{df}{dx} = 2x.$$

Using other notation:

$$f'(x) = 2x$$

Notice the slant in  $df$ . For an upright d, type the following in the preamble:

```
\newcommand{\dee}{\mathrm{d}}
```

`\dee` is my choice, so you can use something else.

```
$$\frac{\dee f}{\dee x} = 2x$$
```

$$\frac{df}{dx} = 2x$$

If you need to evaluate derivatives:

```
$$\left.\frac{\dee f}{\dee x}\right|_{x=2}=4$$
```

$$\left.\frac{df}{dx}\right|_{x=2} = 4$$

Partial derivatives are typeset using `\partial`.

```
$$\frac{\partial g}{\partial y} \frac{\partial g}{\partial x}$$
```

$$\frac{\partial g}{\partial x \partial y}$$

## diffcoeff package

diffcoeff with the ISO option also takes care of the upright d. It is also handy for higher-order and partial derivatives.

```
% Preamble
\usepackage[ISO]{diffcoeff}
```

Typesetting ordinary derivatives:

```
$$\diff{f}{x}$$
$$\diff{f}/{x}$$
$$\diff[n]{f}{x}$$
$$\diff[n]{f}/{x}$$
$$\diff{\cos(\sin x)}{(\sin x)}$$
$$\diff[n]{\cos(\sin{x})}{\sin{x}}$$
$$\diff*{f(x)}{x}$$
$$\diff*{\diff{y}{x}}{x}$$
$$\diff[n]{f}{x}[x=0]$$
```

$$\begin{array}{c} \frac{df}{dx} \\ df/dx \\ \frac{d^n f}{dx^n} \\ d^n f/dx^n \\ \frac{d \cos(\sin x)}{d(\sin x)} \\ \frac{d^n \cos(\sin x)}{d(\sin x)^n} \\ \frac{d}{dx} f(x) \\ \frac{d}{dx} \frac{dy}{dx} \\ \left( \frac{d^n f}{dx^n} \right)_{x=0} \end{array}$$

Typesetting partial derivatives:

```

 $\frac{\partial f}{\partial x}$ 
 $\frac{\partial^n f}{\partial x^n}$ 
 $\frac{\partial^n f}{\partial x^n}$ 
 $\left(\frac{\partial^n f(x,y)}{\partial x^n}\right)_{(0,0)}$ 
 $\frac{\partial^3 f}{\partial x \partial y \partial z}$ 
 $\frac{\partial^{10} f(x,y,z,w)}{\partial x^2 \partial y^3 \partial z^4 \partial w}$ 

```

$$\frac{\partial f}{\partial x}$$

$$\frac{\partial^n f}{\partial x^n}$$

$$\frac{\partial^n f}{\partial x^n}$$

$$\left(\frac{\partial^n f(x,y)}{\partial x^n}\right)_{(0,0)}$$

$$\frac{\partial^3 f}{\partial x \partial y \partial z}$$

$$\frac{\partial^{10} f(x,y,z,w)}{\partial x^2 \partial y^3 \partial z^4 \partial w}$$

More package information can be found on [CTAN](#).

## 7.12.2 Integration

Refer to 7.11.3 on page 56 and replace `sum` with `int`. To include the differential, add `\, \mathrm{d} x`.

The integral  $\int_0^\infty e^x \mathrm{d} x$  diverges.

The integral  $\int_0^\infty e^x \mathrm{d} x$  diverges.

$\int_0^2 2x \mathrm{d} x = \left[x^2\right]_0^2 = 4$

$$\int_0^2 2x \mathrm{d} x = [x^2]_0^2 = 4$$

For multiple integrals, use `\int` multiple times.

If  $I_1 = I_2 = [0, 2]$ , then

$$\int_{I_1} \int_{I_2} xy \mathrm{d} x \mathrm{d} y = 4$$

Explicitly:

$$\int_0^2 \int_0^2 xy \mathrm{d} x \mathrm{d} y = 4$$

If  $I_1 = I_2 = [0, 2]$ , then

$$\int_{I_1} \int_{I_2} xy \mathrm{d} x \mathrm{d} y = 4$$

Explicitly:

$$\int_0^2 \int_0^2 xy \mathrm{d} x \mathrm{d} y = 4$$

Different types of integrals:

```
% Integral with Specified Limits
  (Besides Integral)

$$\int_{-\infty}^{\infty} f = 0$$


% Integral with Specified Limits
  (Under Integral)

$$\int\limits_{-\infty}^{\infty} f = 0$$


% Double / Surface Integral

$$\iint_A f = F$$


% Triple / Volume Integral

$$\iiint_V f = F$$


% Quadruple Integral

$$\iiint_V f = F$$


% Multiple Integral

$$\int \cdots \int_V f = F$$


% Line Integral

$$\oint_V f = F$$

```

$$\int_{-\infty}^{\infty} f = 0$$

$$\int\limits_{-\infty}^{\infty} f = 0$$

$$\iint_A f = F$$

$$\iiint_V f = F$$

$$\int \cdots \int_V f = F$$

$$\oint_V f = F$$

## 7.12.3 Multivariable Calculus

Description	Command	Output
Gradient	<code>\nabla{f}</code>	$\nabla f$
Divergence	<code>\nabla\cdot{F}</code>	$\nabla \cdot F$
Divergence	<code>\nabla\times{f}</code>	$\nabla \times F$
Laplace Operator	<code>\Delta{f}</code>	$\Delta f$
D'Alembert Operator	<code>\square{f}</code>	$\square f$

## 7.13 Analysis

### 7.13.1 Sequences

Use `()` to denote sequences.

Let  $(a_n) = (1, 2, 3, 4, 5, \dots)$  be a sequence.  
Then  $n \rightarrow \infty \implies a_n \rightarrow \infty$ .

Let  $(a_n) = (1, 2, 3, 4, 5, \dots)$  be a sequence. Then

$$n \rightarrow \infty \implies a_n \rightarrow \infty.$$

## 7.13.2 Limits

Limits can also be typeset easily.

If the limit of  $f(x)$  exists at  $x=a$ , then  
 $(\forall \epsilon > 0)(\exists \delta > 0)(0 < |x-a| < \delta \implies |f(x)-f(a)| < \epsilon)$ .

If the limit of  $f(x)$  exists at  $x = a$ , then  
 $(\forall \epsilon > 0)(\exists \delta > 0)(0 < |x - a| < \delta \implies |f(x) - f(a)| < \epsilon)$ .

*% Inline Mode*  
 $\lim_{n \rightarrow \infty} \frac{1}{n} = 0$

$$\lim_{n \rightarrow \infty} \frac{1}{n} = 0$$

$\lim_{n \rightarrow 2^+} \frac{1}{n} = \frac{1}{2}$

$$\lim_{n \rightarrow 2^+} \frac{1}{n} = \frac{1}{2}$$

*% Display Mode*  

$$\lim_{n \rightarrow \infty} \frac{1}{n} = 0$$

$$\lim_{n \rightarrow \infty} \frac{1}{n} = 0$$

$f'(x) = \lim_{h \rightarrow 0^+} \frac{f(x+h) - f(x)}{h}$

$$f'(x) = \lim_{h \rightarrow 0^+} \frac{f(x+h) - f(x)}{h}$$

`\substack` (refer to 7.11.3 on page 56) can also be applied to limits.

## 7.13.3 Infimum & Supremum

For limit inferior and superior, replace `\lim` with `\liminf` and `\limsup`, respectively.

*% Limit Superior*  
 $\limsup_{n \rightarrow \infty} x_n = 1$   
 $\varlimsup_{n \rightarrow \infty} x_n = 1$

$$\limsup_{n \rightarrow \infty} x_n = 1$$

$$\overline{\lim}_{n \rightarrow \infty} x_n = 1$$

*% Limit Inferior*  
 $\liminf_{n \rightarrow \infty} x_n = -1$   
 $\varliminf_{n \rightarrow \infty} x_n = -1$

$$\liminf_{n \rightarrow \infty} x_n = -1$$

$$\underline{\lim}_{n \rightarrow \infty} x_n = -1$$

## Mathematics

---

Other important commands include:

Description	Command	Output
Minimum	<code>\min{A}</code>	$\min A$
Maximum	<code>\max{A}</code>	$\max A$
Infimum	<code>\inf{A}</code>	$\inf A$
Supremum	<code>\sup{A}</code>	$\sup A$

### 7.13.4 Big O Notation

Description	Command	Output
Small o	<code>o(g)</code>	$o(g)$
Big O	<code>\mathcal{O}(g)</code>	$\mathcal{O}(g)$
Big Theta	<code>\Theta(g)</code>	$\Theta(g)$
Big Omega	<code>\Omega(g)</code>	$\Omega(g)$
Small omega	<code>\omega(g)</code>	$\omega(g)$

## 7.14 Abstract Algebra

### 7.14.1 Equivalence Classes & Relations

Description	Command	Output
Equivalence Class	<code>[a]</code>	$[a]$
Equivalence Relation	<code>\sim</code>	$\sim$
Equivalence Relation	<code>\backsim</code>	$\backsim$



## 7.14.2 Group Theory

Description	Command	Output
Group Isomorphism	<code>\simeq</code>	$\simeq$
Direct Product	<code>\times</code>	$\times$
Semi-Direct Product	<code>\rtimes</code>	$\rtimes$
Wreath Product	<code>\wr</code>	$\wr$
Subgroup	<code>\leq</code>	$\leq$
Normal Subgroup	<code>\vartriangleleft</code>	$\triangleleft$
Not a Normal Subgroup	<code>\not\vartriangleleft</code>	$\ntriangleleft$
Quotient Group	<code>G / H</code>	$G/H$
Index of a Subgroup	<code>[G : H]</code>	$[G : H]$
Generator	<code>\langle X \rangle</code>	$\langle X \rangle$
Commutator	<code>[g, h]</code>	$[g, h]$

## 7.14.3 Field Theory

Description	Command	Output
Field Extension	<code>L : K</code>	$L : K$
Degree of Field Extension	<code>[L : K]</code>	$[L : K]$
Algebraic Closure	<code>\overline{K}</code>	$\overline{K}$

## 7.15 Discrete Mathematics

### 7.15.1 Number Theory

Description	Command	Output
Divides	<code>a \mid b</code>	$a \mid b$
Does Not Divide	<code>a \nmid b</code>	$a \nmid b$
Congruence With ()	<code>a \equiv b \pmod{n}</code>	$a \equiv b \pmod{n}$
Congruence Without ()	<code>a \equiv b \mod{n}</code>	$a \equiv b \mod n$
Greatest Common Divisor	<code>\gcd(100, 10)</code>	$\gcd(100, 10)$
Euler's Totient Function	<code>\phi(n)</code>	$\phi(n)$

### 7.15.2 Continued Fractions

`\cfrac` does the job. The options `[r]` or `[1]` determine the position of the numerator.

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```
\begin{equation*}
x = x_{0} + \cfrac{y_{0}}{
x_{1} + \cfrac{y_{1}}{
x_{2} + \cfrac{1}{y_{2}}\{
x_{3} + \cfrac{r}{y_{3}}\{
x_{4} + \cdots\}\}\}
}\end{equation*}
```

$$x = x_0 + \frac{y_0}{x_1 + \frac{y_1}{x_2 + \frac{y_2}{x_3 + \frac{y_3}{x_4 + \cdots}}}}$$

### 7.15.3 Combinatorics

Description	Command	Output
Factorial	<code>n!</code>	$n!$
Double Factorial	<code>n!!</code>	$n!!$
Derangement	<code>!n</code>	$!n$
Combination	<code>\binom{n}{k}</code>	$\binom{n}{k}$
Multinomial Coefficient	<code>\binom{n}{k_1, k_2, \ldots, k_r}</code>	$\binom{n}{k_1, k_2, \ldots, k_r}$
Multiset	<code>\left(\binom{n}{k}\right)</code>	$\left(\binom{n}{k}\right)$
Primorial	<code>n\#</code>	$n\#$

You can also use `\dbinom` for a **d**isplay mode sized binomial and `\tbinom` for a **t**ext mode sized binomial.

## 7.16 Stochastics (Probability & Statistics)

### 7.16.1 Probability

Description	Command	Output
Probability Measure	<code>P(E)</code>	$P(E)$
Conditional Probability	<code>P(A \mid B)</code>	$P(A \mid B)$
Expected Value	<code>E(X)</code>	$E(X)$
Variance	<code>\mathrm{Var}(X)</code>	$\mathrm{Var}(X)$
Standard Deviation	<code>\sigma(X)</code>	$\sigma(X)$
Covariance	<code>\mathrm{Cov}(X, Y)</code>	$\mathrm{Cov}(X, Y)$
Correlation	<code>\rho(X, Y)</code>	$\rho(X, Y)$
Probability Distribution	<code>X \sim Y</code>	$X \sim Y$

## 7.16.2 Statistics

Description	Command	Output
Mean	<code>\overline{x}</code>	$\bar{x}$
Estimator	<code>\hat{p}</code>	$\hat{p}$

## 7.17 Linear Algebra

### 7.17.1 Vectors

Vectors are denoted using `\vec`.

`$_\vec{a}$`

$\vec{a}$

Bold vectors require `\boldsymbol`. Typing this out can be cumbersome, so define a new command in the preamble.

```
\newcommand{\bvec}[1]{\boldsymbol{#1}}
```

Using the new command:

`$_\bvec{a}$`

$\boldsymbol{a}$

Vectors are defined within a `matrix`<sup>3</sup>, `pmatrix`, `bmatrix`, or `Bmatrix` environment.

Row vectors:

```
% Row Vector (no fences)
\begin{equation*}
\begin{matrix}
1 & 2 & 3
\end{matrix}
\end{equation*}
```

1 2 3

```
% Row Vector (round brackets)
\begin{equation*}
\begin{pmatrix}
1 & 2 & 3
\end{pmatrix}
\end{equation*}
```

(1 2 3)

---

<sup>3</sup>The array environment does the same thing but is not preferred.

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---

*% Row Vector (square brackets)*

```
\begin{equation*}
```

```
\begin{bmatrix}
```

```
1 & 2 & 3
```

```
\end{bmatrix}
```

```
\end{equation*}
```

$$\begin{bmatrix} 1 & 2 & 3 \end{bmatrix}$$

*% Row Vector (curly braces)*

```
\begin{equation*}
```

```
\begin{Bmatrix}
```

```
1 & 2 & 3
```

```
\end{Bmatrix}
```

```
\end{equation*}
```

$$\{1 \quad 2 \quad 3\}$$

Column vectors:

*% Column Vector (no delimiters)*

```
\begin{equation*}
```

```
\begin{matrix}
```

```
1 \\
```

```
2 \\
```

```
\vdots \\
```

```
3
```

```
\end{matrix}
```

```
\end{equation*}
```

$$\begin{matrix} 1 \\ 2 \\ \vdots \\ 3 \end{matrix}$$

*% Column Vector (round brackets)*

```
\begin{equation*}
```

```
\begin{pmatrix}
```

```
1 \\
```

```
2 \\
```

```
\vdots \\
```

```
3
```

```
\end{pmatrix}
```

```
\end{equation*}
```

$$\begin{pmatrix} 1 \\ 2 \\ \vdots \\ 3 \end{pmatrix}$$

*% Column Vector (square brackets)*

```
\begin{equation*}
```

```
\begin{bmatrix}
```

```
1 \\
```

```
2 \\
```

```
\vdots \\
```

```
3
```

```
\end{bmatrix}
```

```
\end{equation*}
```

$$\begin{bmatrix} 1 \\ 2 \\ \vdots \\ 3 \end{bmatrix}$$

```
% Column Vector (curly braces)
\begin{equation*}
\begin{Bmatrix}
1 \\
2 \\
\vdots \\
3
\end{Bmatrix}
\end{equation*}
```

$$\begin{Bmatrix} 1 \\ 2 \\ \vdots \\ 3 \end{Bmatrix}$$

## 7.17.2 Matrices

Use the exact same environments mentioned in [7.17.1](#).

```
% Matrix (no delimiters)
\begin{equation*}
\begin{matrix}
1 & 2 & 3 \\
4 & 5 & 6
\end{matrix}
\end{equation*}
```

$$\begin{matrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{matrix}$$

```
% Matrix (round brackets)
\begin{equation*}
\begin{pmatrix}
a_{11} & \cdots & a_{1n} \\
\vdots & \ddots & \vdots \\
a_{m1} & \cdots & a_{mn}
\end{pmatrix}
\end{equation*}
```

$$\begin{pmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \cdots & a_{mn} \end{pmatrix}$$

```
% Matrix (square brackets)
\begin{equation*}
\begin{bmatrix}
1 & 2 \\
4 & 5
\end{bmatrix}
\end{equation*}
```

$$\begin{bmatrix} 1 & 2 \\ 4 & 5 \end{bmatrix}$$

```
% Matrix (curly braces)
\begin{equation*}
\begin{Bmatrix}
1 & 2 \\
3 & 4 \\
5 & 6
\end{Bmatrix}
\end{equation*}
```

$$\begin{Bmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{Bmatrix}$$

## Mathematics

---

If you need matrices with different delimiters, then you add them to a plain `matrix` using `\left` and `\right`.

```
% Matrix (custom delimiters)
$
\left(
\begin{matrix}
1 & 2 \\
3 & 4
\end{matrix}
\right)
$,
$
\left\lceil
\begin{matrix}
1 & 2 \\
3 & 4
\end{matrix}
\right\rceil
$
```

$$\left(\begin{array}{cc} 1 & 2 \\ 3 & 4 \end{array}\right), \left\lceil\begin{array}{cc} 1 & 2 \\ 3 & 4 \end{array}\right\rceil$$

Even in inline mode, matrices are in display style. For smaller matrices, use `smallmatrix`, `psmallmatrix`, or `bsmallmatrix`.

```
% Small Matrix (no delimiters)
$
\begin{smallmatrix}
1 & 2 \\
3 & 4
\end{smallmatrix}
$ is a $2 \times 2$ matrix.
```

$$\begin{smallmatrix} 1 & 2 \\ 3 & 4 \end{smallmatrix} \text{ is a } 2 \times 2 \text{ matrix.}$$

```
% Small Matrix (round brackets)
$
\begin{psmallmatrix}
1 & 2 \\
3 & 4
\end{psmallmatrix}
$ is a $2 \times 2$ matrix.
```

$$\left(\begin{smallmatrix} 1 & 2 \\ 3 & 4 \end{smallmatrix}\right) \text{ is a } 2 \times 2 \text{ matrix.}$$

```
% Small Matrix (square brackets)
$
\begin{bsmallmatrix}
1 & 2 \\
3 & 4
\end{bsmallmatrix}
$ is a $2 \times 2$ matrix.
```

$$\left[\begin{smallmatrix} 1 & 2 \\ 3 & 4 \end{smallmatrix}\right] \text{ is a } 2 \times 2 \text{ matrix.}$$

```
% Small Matrix (custom brackets)
$
\left(
\begin{smallmatrix}
1 & 2 \\
3 & 4
\end{smallmatrix}
\right)
$ is a $2 \times 2$ matrix.
```

$\begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$  is a  $2 \times 2$  matrix.

## 7.17.3 Determinants

Use the `vmatrix` environment.

```
\begin{equation*}
\begin{vmatrix}
1 & 2 \\
3 & 4
\end{vmatrix}
= 1 \cdot 4 - 2 \cdot 3 = -2
\end{equation*}
```

$$\begin{vmatrix} 1 & 2 \\ 3 & 4 \end{vmatrix} = 1 \cdot 4 - 2 \cdot 3 = -2$$

An alternative is:

```
\begin{equation*}
\left|
\begin{matrix}
1 & 2 \\
3 & 4
\end{matrix}
\right|
= 1 \cdot 4 - 2 \cdot 3 = -2
\end{equation*}
```

$$\left| \begin{matrix} 1 & 2 \\ 3 & 4 \end{matrix} \right| = 1 \cdot 4 - 2 \cdot 3 = -2$$

You can also use `\det`.

```
The determinant of $A$ is
\begin{equation*}
\det\left(
\begin{pmatrix}
1 & 2 \\
3 & 4
\end{pmatrix}
\right)
= 1 \cdot 4 - 2 \cdot 3 = -2
\end{equation*}
```

The determinant of  $A$  is

$$\det\left(\begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}\right) = 1 \cdot 4 - 2 \cdot 3 = -2$$

## 7.17.4 Matrix Norm

Use the `Vmatrix` environment.

```
\begin{equation*}
\begin{Vmatrix}
1 & 2 \\
3 & 4
\end{Vmatrix}
\end{equation*}
```

$$\left\| \begin{matrix} 1 & 2 \\ 3 & 4 \end{matrix} \right\|$$

An alternative is:

```
\begin{equation*}
\left\| \begin{matrix}
1 & 2 \\
3 & 4
\end{matrix} \right\|
\end{equation*}
```

$$\left\| \begin{matrix} 1 & 2 \\ 3 & 4 \end{matrix} \right\|$$

## 7.17.5 Vector Calculus

Description	Command	Output
Dot Product	<code>v \cdot w</code>	$v \cdot w$
Inner Product	<code>\langle v, w \rangle</code>	$\langle v, w \rangle$
Cross Product	<code>v \times w</code>	$v \times w$
Triple Product	<code>(u, v, w)</code>	$(u, v, w)$
Dyadic Product	<code>v \otimes w</code>	$v \otimes w$
Unit Vector	<code>\hat{v}</code>	$\hat{v}$



## 7.17.6 Matrix Operations

Description	Command	Output
Matrix Multiplication	<code>A \cdot B</code>	$A \cdot B$
Hadamard Product	<code>A \circ B</code>	$A \circ B$
Kronecker Product	<code>A \otimes B</code>	$A \otimes B$
Matrix Transpose	<code>A^{T}</code>	$A^T$
Conjugate Transpose	<code>A^{*}</code>	$A^*$
Inverse Matrix	<code>A^{-1}</code>	$A^{-1}$
Trace	<code>\mathrm{tr}(A)</code>	$\mathrm{tr}(A)$
Determinant	<code>\det(A)</code>	$\det(A)$
Determinant	<code> A </code>	$ A $
Matrix Norm	<code>\ A\ </code>	$\ A\ $
Rank	<code>\mathrm{rank}(A)</code>	$\mathrm{rank}(A)$
Span	<code>\mathrm{span}(A)</code>	$\mathrm{span}(A)$

## 7.17.7 Vector Spaces

Description	Command	Output
Kernel	<code>\ker{W}</code>	$\ker W$
Dimension	<code>\dim{W}</code>	$\dim W$
Degree	<code>\degree{P(x)}</code>	$\deg P(x)$
Direct Sum	<code>V \oplus W</code>	$V \oplus W$
Direct Product	<code>V \times W</code>	$V \times W$
Tensor Product	<code>V \otimes W</code>	$V \otimes W$
Quotient Space	<code>V / W</code>	$V/W$
Orthogonal Complement	<code>W^{\perp}</code>	$A^\perp$
Dual Space	<code>V^{*}</code>	$V^*$
Linear Hull	<code>\langle X \rangle</code>	$\langle X \rangle$

## 7.18 Overriding Default Math Styles

Suppose you want a display mode style sum in between text. How do you do that? Fortunately,  $\text{\LaTeX}$  provides commands to override the default style that math is typeset.

- `\textstyle` - inline math style.
- `\displaystyle` - display math style.

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- `\scriptstyle` - sub/superscript math style.
- `\scriptscriptstyle` - second order sub/superscript math style.

These commands are useful with sums, products, integral, and limits.

*% Display Mode*

`$$\sum_{n=1}^{10}\{n\}$$`

*% Text Style in Display Mode*

`$$\textstyle\sum_{n=1}^{10}\{n\}$$`

*% Other Styles*

`$$\scriptscriptstyle\sum_{n=1}^{10}\{n\}$$,`

`$$\scriptstyle\sum_{n=1}^{10}\{n\}$$,`

`$$\sum_{n=1}^{10}\{n\}$$,`

`$$\displaystyle\sum_{n=1}^{10}\{n\}$$`

$$\sum_{n=1}^{10} n$$

$$\sum_{n=1}^{10} n$$

$$\sum_{n=1}^{10} n, \sum_{n=1}^{10} n, \sum_{n=1}^{10} n, \sum_{n=1}^{10} n$$

## 7.19 Coloring Math

Coloring math is similar to coloring text (refer to 4.7 on page 20).

`$$\frac{\textcolor{blue}{5}}{10}=\frac{1}{\textcolor{red}{10}}$$`

$$\frac{5}{10} = \frac{1}{10}$$

## 7.20 Homework

There are a few templates for homework assignments that I have uploaded to [GitHub](#). More templates can be found on [Overleaf](#).

### Helpful Resources

1. [Wikibooks](#) - a thorough guide for typesetting mathematics.
2. [AMS Math Guide for L<sup>A</sup>T<sub>E</sub>X](#) - a guide to L<sup>A</sup>T<sub>E</sub>X by the American Mathematical Society.
3. [The Grammar of Mathematics](#) - how to write math.

# Chapter 8

## Structures

### 8.1 Lists

Different environments render different lists.

- `itemize` - unordered list (bullet points).
- `enumerate` - ordered list (numbers).
- `description` - description list (words).

Grocery list:

```
\begin{itemize}
  \item Pineapples
  \item More Pineapples
  \item Even More Pineapples
\end{itemize}
```

Grocery list:

- Pineapples
- More Pineapples
- Even More Pineapples

Premier League Top 4:

```
\begin{enumerate}
  \item Manchester United
  \item Manchester City
  \item Liverpool
  \item Chelsea
\end{enumerate}
```

Premier League Top 4:

1. Manchester United
2. Manchester City
3. Liverpool
4. Chelsea

## Structures

```
Bull's Starting Line-up:
\begin{description}
  \item[PG] Lonzo Ball
  \item[SG] Zach Lavine
  \item[SF] DeMar DeRozan
  \item[PF] Javonte Green
  \item[C] Nikola Vučević
\end{description}
```

Bull's Starting Line-up:

**PG** Lonzo Ball

**SG** Zach Lavine

**SF** DeMar DeRozan

**PF** Javonte Green

**C** Nikola Vučević

You can also nest lists.

```
Bull's Starting Line-up:
\begin{description}
  \item[PG] Lonzo Ball
  \begin{description}
    \item Bench
    \begin{itemize}
      \item[\textbf{\#6}] Alex
        Caruso
      \item Coby White
    \end{itemize}
  \end{description}
  \item[SG] Zach Lavine
  \item[SF] DeMar DeRozan
  \item[PF] Javonte Green
  \item[C] Nikola Vučević
\end{description}
```

Bull's Starting Line-up:

**PG** Lonzo Ball

Bench

**#6** Alex Caruso

▪ Coby White

**SG** Zach Lavine

**SF** DeMar DeRozan

**PF** Javonte Green

**C** Nikola Vučević

More information on lists can be found [here](#).

## 8.2 Tables

The table and tabular environments are used to create tables.

### 8.2.1 The table environment

## Structures

```
\begin{table}[c] % t = top of the
                 page; c = center of the page b =
                 bottom of the page
```

```
% Title of the table
\caption{Basic Table}
```

Table 8.1: Basic Table

```
% Centers table (table is aligned to
                 left by default)
\centering
\end{table}
```

- `c` specifies the position of the table within the page.
- To place table at precisely the location in the  $\text{\LaTeX}$  code, load the `float` package and use `H` instead of `c`.
- To right align the table, place the code in a `flushright` environment.

To fill in the table contents, start a `tabular` environment.

```
\begin{center} % You can also use
               the center environment
\begin{table}[c]
\caption{Basic Table}
```

```
% 3 columns: l = left justified
               contents; c = centered column
               contents; r = right justified
               contents
```

```
\begin{tabular}{l c r}
1 & 2 & 3 \\
4 & 5 & 6 \\
\end{tabular}
\end{table}
\end{center}
```

Table 8.2: Basic Table

1	2	3
4	5	6

- Column widths and spacing are automatically defined.
- `&` separates columns.
- `\\` separates rows.
- For simple tables, you may only need the `tabular` environment.

## Structures

---

Notice the small gap between the table contents and title. The caption package solves this. Add the following to the preamble.

```
\usepackage{caption}
\captionsetup[table]{skip=10pt}
```

The caption package provides more customization options. Read [this](#) tutorial for more information.

### 8.2.2 The tabular environment

The tabular environment was introduced in the last section. Let's continue adding features to it.

```
\centering
```

```
\begin{tabular}[c]{|| 1 | c | r ||}
\hline
Col 1 & Col 2 & Col 3 \\\ [0.2ex] %
    Headings
1 & 2 & 3 \\\
\hline
4 & 5 & 6 \\\
\hline
7 & 8 & 9 \\\
\hline\hline
\end{tabular}
```

Col 1	Col 2	Col 3
1	2	3
4	5	6
7	8	9

- | adds a vertical line between columns.
- || adds a double vertical line between columns.
- \hline adds a horizontal line between rows.
- \hline\hline adds a double horizontal line between rows.
- There is no need \\ after \hline.
- Add space between rows with square brackets []

## Structures

`\centering`

```
\begin{tabular}[c]{l c r}
\hline
Col 1 & Col 2 & Col 3 \\ \hline
1 & 2 & 3 \\ \hline
4 & 5 & 6 \\ \hline
7 & 8 & 9 \\ \hline
\end{tabular}
```

Col 1	Col 2	Col 3
1	2	3
4	5	6
7	8	9

- `\cline{m-n}` adds a horizontal line between columns *m* and *n*.

`\centering`

```
\begin{tabular}[c]{l l | c | r |
p{2.5cm} |}
\hline
Col 1 & Col 2 & Col 3 & Text \\
[0.2ex]
1 & 2 & 3 & Numbers from 1-3. \\ \hline
4 & 5 & 6 & Numbers from 4-6. \\ \hline
7 & 8 & 9 & Numbers from 7-9. \\ \hline
\end{tabular}
```

Col 1	Col 2	Col 3	Text
1	2	3	Numbers from 1-3.
4	5	6	Numbers from 4-6.
7	8	9	Numbers from 7-9.

- `\p{2.5cm}` specifies a paragraph column with text vertically aligned at the top.

More complex tables involving merging rows and columns. Use `\multicolumn` to merge cells over multiple columns.

## Structures

`\centering`

```
\begin{tabular}[c]{| l | c | r |}
\hline
Col 1 & Col 2 & Col 3 \\ \hline
1 & \multicolumn{2}{c}{2, 3} \\ \hline
\multicolumn{3}{c}{4, 5, 6} \\ \hline
7 & 8 & 9 \\ \hline
\end{tabular}
```

Col 1	Col 2	Col 3
1	2, 3	
4, 5, 6		
7	8	9

- `\multicolumn` removes the vertical lines, so specify them.

`\centering`

```
\begin{tabular}[c]{| l | c | r |}
\hline
Col 1 & Col 2 & Col 3 \\ \hline
1 & \multicolumn{2}{| c |}{2, 3} \\ \hline
\multicolumn{3}{| c |}{4, 5, 6} \\ \hline
7 & 8 & 9 \\ \hline
\end{tabular}
```

Col 1	Col 2	Col 3
1	2, 3	
4, 5, 6		
7	8	9

Load the `multirow` package and use `\multirow` to merge cells over multiple rows.



## Structures

`\centering`

```
\begin{tabular}{|c|c|c|}  
\hline  
\multicolumn{3}{|c|}{Bulls Roster}  
\hline  
\multirow{2}{*}{Point Guards}  
& PG1 & Lonzo B. \\  
& PG2 & Alex C. \\  
\hline  
\multirow{2}{*}{Shooting Guards}  
& SG1 & Zach L. \\  
& SG2 & Ayo D. \\  
\hline  
\multirow{2}{*}{Small Forwards}  
& SF1 & DeMar D. \\  
& SF2 & Derrick J. \\  
\hline  
\multirow{2}{*}{Power Forwards}  
& PF1 & Patrick W. \\  
& PF2 & Javonte G. \\  
\hline  
\multirow{2}{*}{Centers}  
& C1 & Nikola V. \\  
& C2 & Tony B. \\  
\hline  
\end{tabular}
```

Bulls Roster		
Point Guards	PG1 PG2	Lonzo B. Alex C.
Shooting Guards	SG1 SG2	Zach L. Ayo D.
Small Forwards	SF1 SF2	DeMar D. Derrick J.
Power Forwards	PF1 PF2	Patrick W. Javonte G.
Centers	C1 C2	Nikola V. Tony B.

- \* tells  $\text{\LaTeX}$  that the column width is determined by its content.

### Helpful Resources

1. [Table to  \$\text{\LaTeX}\$  generators](#) - converts drawn table to  $\text{\LaTeX}$ .
2. [Overleaf](#) - positioning tables.
3. [Wikibooks](#) - an advanced guide for tables.

## 8.3 Images

1. Save the image in the folder your document is saved in (as a EPS, JPEG, PDF, or PNG).

## Structures

---

2. Load the `graphicx` package.
3. Use `\includegraphics`.

```
\begin{center}  
\includegraphics[width=5cm,  
    height=3cm, angle=0,  
    scale=1]{ronaldo.jpeg}  
\end{center}
```



Sometimes images and text do not work well together, so images must be placed in a figure environment. It is similar to the table environment in some ways.

```
\begin{center}  
\begin{figure}  
\caption{The \textbf{SIU}}  
\includegraphics[width=5cm,  
    height=3cm, angle=0,  
    scale=1]{ronaldo.jpeg}  
\end{figure}  
\end{center}
```

Figure 8.1: The **SIU**



More information on inserting images can be found [here](#).

# Chapter 9

## Navigation

### 9.1 Table of Contents

Use `\tableofcontents` in the body of the document.

### 9.2 List of Tables & Figures

Use `\listoftables` and `\listoffigures` in the body of the document.

### 9.3 Abstract

Add the following code to the document body:

```
\chapter*{Abstract}

% Adding Abstract to Table of Contents
\addcontentsline{toc}{chapter}{Abstract}
```

An alternative solution is to use the `abstract` environment.

```
\begin{abstract}
This guide serves as an introduction to \LaTeX{}. I hope new users find it
  useful.
\end{abstract}
```

### 9.4 Acknowledgements

Add the following code to the document body:

```
\chapter*{Acknowledgements}

% Adding Acknowledgements to Table of Contents
\addcontentsline{toc}{chapter}{Acknowledgements}
```

### 9.5 Appendix

Load the appendix package as follows:

```
% Preamble
\usepackage[toc]{appendix} % Includes appendices in Table of Contents

% Body
\begin{appendices}
\chapter{Riemann Hypothesis Proof}
Sir Michael Atiyah claims the proof for the Riemann Hypothesis is as follows...
\end{appendices}
```

### 9.6 Bibliography

Watch [this](#) video. A few things to remember:

- Run the compilers below in the order stated:
  1.  $\text{\LaTeX}$ <sup>1</sup>
  2.  $\text{BibTeX}$
  3.  $\text{\LaTeX}$  ( $\times 2$ )
- Other bibliography styles can be found [here](#).
- When you use `\bibliography`, the .bib file name must be within the `{}`.
- When you use `\cite`, the name must within `{}` must match the name in the .bib file.

---

<sup>1</sup>You can use  $\text{XeLaTeX}$  or  $\text{LuaLaTeX}$  instead.

### 9.7 Index

Load the `imakeidx` package and type the following code:

```
% Preamble
\usepackage{imakeidx}

% Alphabetical Index
\begin{filecontents*}{\jobname.mst}
headings_flag 1
heading_prefix "\\par\\penalty-50\\textbf{"
heading_suffix "}\\\\\\*\\~\\\\\\*"
symhead_positive "Symbols"
symhead_negative "symbols"
numhead_positive "Numbers"
numhead_negative "numbers"
delim_0 ",\\~"
\end{filecontents*}

% Making the Index
\makeindex[intoc]

% Body

% Making an Index entry
This is the first index\index{first entry} entry.

% Printing the Index
\printindex
```

Next, run the compilers below in the order stated:

1.  $\text{\LaTeX}^2$
2. MakeIndex
3.  $\text{\LaTeX}$  ( $\times 2$ )

To change the style of index entries, refer to [this](#) table.

### 9.8 Hyperlinks

Load the `href` package.

---

<sup>2</sup>Refer to the footnote in [9.6](#)

## Navigation

---

*% Preamble*

```
\usepackage[colorlinks, urlcolor=blue]{href}
```

Use `\href` to add a link.

```
This is a  
  \href{https://www.google.com}  
{link}.
```

This is a [link](https://www.google.com).

If you just want a URL, then use `\url`.

```
\url{https://www.google.com}  
  provides a pretty good search  
  engine.
```

<https://www.google.com> provides a  
pretty good search engine.

You can also add your email address.

```
\href{mailto:prabhavkumar10@gmail.com}  
{Say Hi!}
```

[Say Hi!](mailto:prabhavkumar10@gmail.com)

More information about hyperlinks can be found [here](#).

# Chapter 10

## Drawing

TikZ is the most powerful graphics tool in  $\text{\LaTeX}$ . While it is quite complex, I introduce the basics.

### 10.1 Lines

Load the tikz package.

```
% Preamble  
\usepackage{tikz}
```

Use `\tikz...` to draw inline. **;** marks the end of the instruction and is necessary.

```
\tikz \draw (0, 0) -- (1, 0); is a  
straight line
```

_____ is a straight line
--------------------------

Use the `tikzpicture` environment for larger pictures.

## Drawing

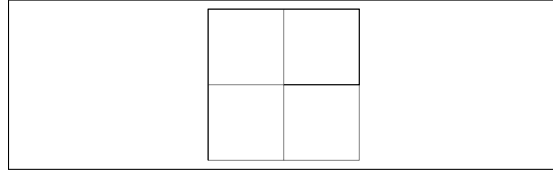
---

```
\centering
\begin{tikzpicture}

% Drawing Grid Lines
\draw[help lines] (-1, -1) grid (1,
1);

% Drawing a Path
\draw (0, 0) -- (1, 0) -- (1, 1) --
(0, 1) -- (-1, 1) -- (-1, 0) --
(-1, -1);

\end{tikzpicture}
```

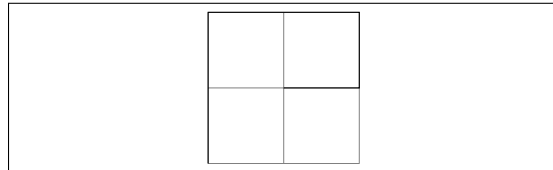


Drawing the same path using |:

```
\centering
\begin{tikzpicture}
\draw[help lines] (-1, -1) grid (1,
1);

% Drawing Same Path
\draw (0, 0) -| (1, 1) -| (-1, -1);

\end{tikzpicture}
```



## 10.2 Points

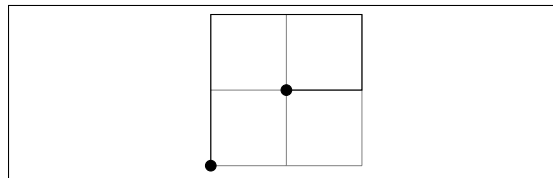
```
\centering
\begin{tikzpicture}

% Drawing Grid Lines
\draw[help lines] (-1, -1) grid (1,
1);

% Drawing a Path
\draw (0, 0) -| (1, 1) -| (-1, -1);

% Starting & Ending Points
\filldraw (0,0) circle (2pt);
\filldraw (-1, -1) circle (2pt);

\end{tikzpicture}
```



## 10.3 Curved Lines



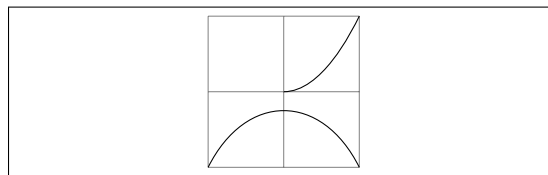
## Drawing

```
\centering
\begin{tikzpicture}
\draw[help lines] (-1, -1) grid (1,
1);

% Drawing a Parabola
\draw (0, 0) parabola (1, 1);

% Drawing a Curved Line
\draw (-1, -1) .. controls (-0.5, 0)
and (0.5, 0) .. (1, -1);

\end{tikzpicture}
```

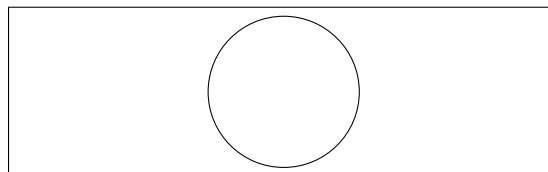


$(-1, -1)$  and  $(1, -1)$  are the start and end points, respectively.  $(-0.5, 0)$  and  $(0.5, 0)$  act like magnets. Make sure there is no whitespace between the 2 periods before and after controls.

### 10.4 Shapes

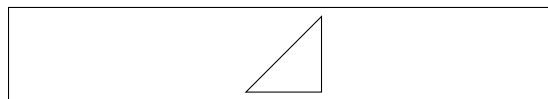
A circle centered at the origin of radius 1:

```
\centering
\begin{tikzpicture}
\draw (0, 0) circle (1);
\end{tikzpicture}
```



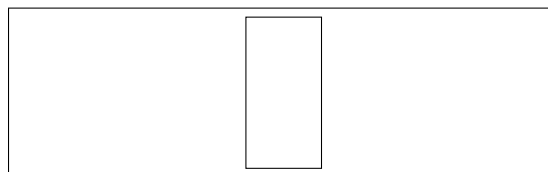
A triangle:

```
\centering
\begin{tikzpicture}
\draw (0, 0) -- (1, 0) -- (1, 1) --
cycle;
\end{tikzpicture}
```



A rectangle:

```
\centering
\begin{tikzpicture}
\draw (0, 0) rectangle (1, 2);
\end{tikzpicture}
```

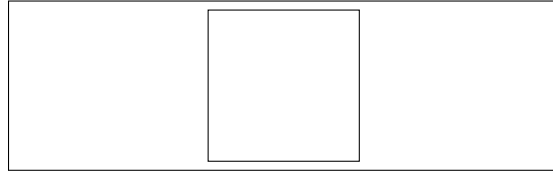


A square:

## Drawing

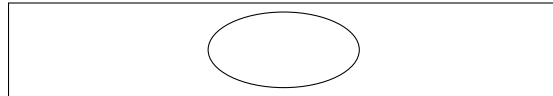
---

```
\centering
\begin{tikzpicture}
\draw (0, 0) rectangle (2, 2);
\end{tikzpicture}
```



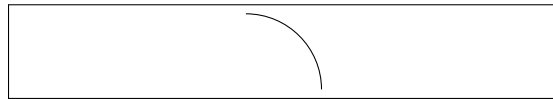
An ellipse centered at the origin with  $x$  and  $y$ -direction radii of 1 and 0.5:

```
\centering
\begin{tikzpicture}
\draw (0, 0) ellipse (1 and 0.5);
\end{tikzpicture}
```



An arc of radius 1 from 0 to 90 degrees:

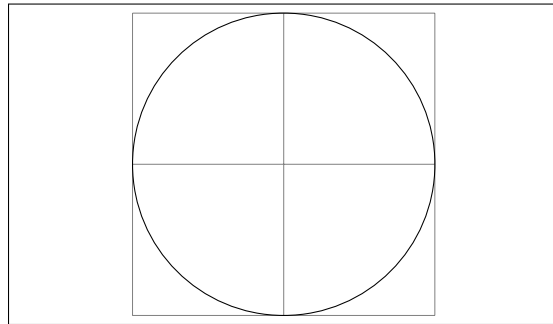
```
\centering
\begin{tikzpicture}
\draw (0, 0) arc (0:90:1);
\end{tikzpicture}
```



## 10.5 Scaling

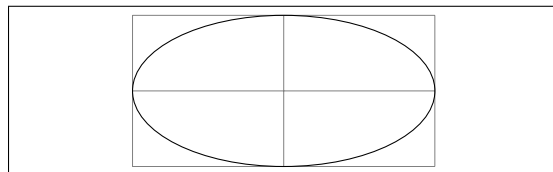
Scaling a drawing by a factor of 2:

```
\centering
\begin{tikzpicture}[scale=2]
\draw[help lines] (-1, -1) grid (1,
1);
\draw (0, 0) circle (1);
\end{tikzpicture}
```



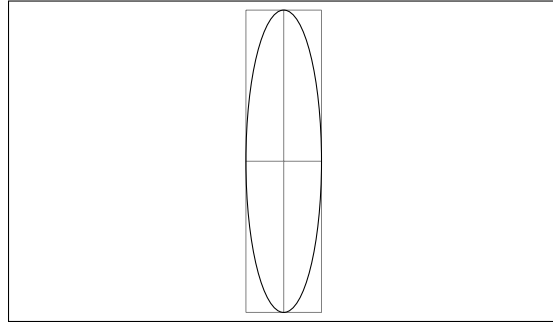
Scaling across the  $x$ -dimension:

```
\centering
\begin{tikzpicture}[xscale=2]
\draw[help lines] (-1, -1) grid (1,
1);
\draw (0, 0) circle (1);
\end{tikzpicture}
```



Scaling across the  $x$  and  $y$ -dimensions:

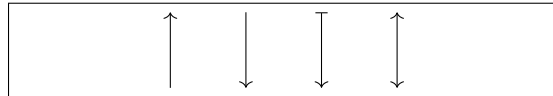
```
\centering
\begin{tikzpicture}[xscale=0.5,
  yscale=2]
\draw[help lines] (-1, -1) grid (1,
  1);
\draw (0, 0) circle (1);
\end{tikzpicture}
```



## 10.6 Decorating Lines

### 10.6.1 Arrows

```
\centering
\begin{tikzpicture}
\draw [->] (0, 0) -- (0, 1);
\draw [<-] (1, 0) -- (1, 1);
\draw [<-|] (2, 0) -- (2, 1);
\draw [<->] (3, 0) -- (3, 1);
\end{tikzpicture}
```



### 10.6.2 Line Thickness

```
\centering
\begin{tikzpicture}

% Pre-defined Thickness %
\draw [ultra thick] (0, 0) -- (0, 1);
\draw [thick] (1, 0) -- (1, 1);
\draw [thin] (2, 0) -- (2, 1);
\draw [very thin] (3, 0) -- (3, 1);

% Custom Thickness %
\draw [line width=3pt] (4, 0) -- (4,
  1);

\end{tikzpicture}
```



### 10.6.3 Line Styles

## Drawing

```
\centering
\begin{tikzpicture}
\draw [dashed, ultra thick] (0, 0)
-- (0, 1);
\draw [dashed, thick] (1, 0) -- (1,
1);
\draw [dotted] (2, 0) -- (2, 1);
\end{tikzpicture}
```



### 10.6.4 Line Color

```
\centering
\begin{tikzpicture}
\draw [red, dashed, ultra thick] (0,
0) -- (0, 1);
\draw [blue, dashed, thick] (1, 0)
-- (1, 1);
\draw [magenta] (2, 0) -- (2, 1);
\end{tikzpicture}
```

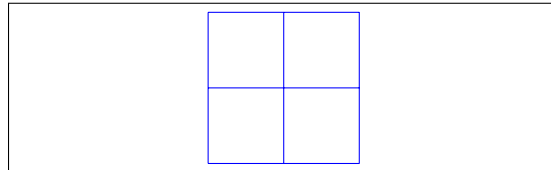


Refer to [4.7](#) to use different colours.

### 10.6.5 Grid Lines

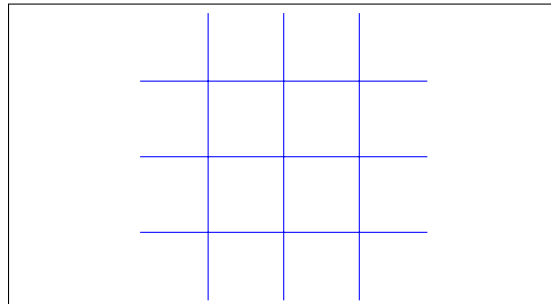
Custom grid lines:

```
\centering
\begin{tikzpicture}
\draw[step=1, blue, thin] (-1, -1)
grid (1, 1);
\end{tikzpicture}
```



Removing outer border:

```
\centering
\begin{tikzpicture}
\draw[step=1, blue, thin] (-1.9,
-1.9) grid (1.9, 1.9);
\end{tikzpicture}
```



### 10.7 Repetition

If you need to reuse lines of code to draw similar things, use `\foreach`.

```
\centering
\begin{tikzpicture}

% Vertical or Horizontal Parallel
% Lines?
\foreach \x in {0,...,100} {
\draw [red, dashed, ultra thin] (\x
* 0.015, 0) -- (\x * 0.015, 1);
};

\end{tikzpicture}
```



You don't need to enter math mode to do math with `\x`.

#### Helpful Resources

I have only scratched the surface of TikZ, so please use these resources, especially if you want to create art.

1. [My Favorite TikZ Manual](#) - learn TikZ visually.
2. [Minimal Introduction TiKZ](#) - a very minimal introduction to TikZ.
3. [Another TikZ Manual](#) - a comprehensive guide for TikZ.
4. [Examples](#) - learn TikZ through examples.
5. [STEM-related Drawings](#) - STEM-related TikZ drawings and their code.

# Chapter 11

## Extending L<sup>A</sup>T<sub>E</sub>X

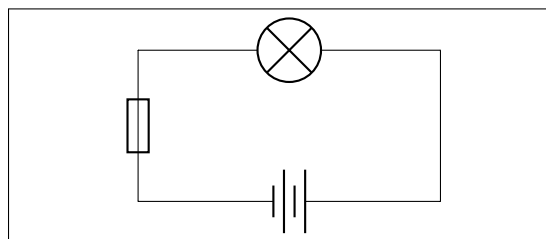
### 11.1 Physics

Physics has a lot of diagrams, so TikZ is important. The rest is basically math<sup>1</sup>. Refer to resource 5 in 10.7.

#### 11.1.1 Circuits

My favorite physics-related package is circuitikz.

```
\centering
\begin{circuitikz}
\draw (0,0) to [lamp] (4,0);
\draw (4,0) to (4, -2);
\draw (4, -2) to [battery] (0, -2);
\draw (0, -2) to [fuse] (0, 0);
\end{circuitikz}
```



More information can be found [here](#).

### 11.2 Chemistry

#### 11.2.1 Basics

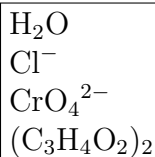
Load the mhchem package and use `\ce` in math mode to write formulae.

---

<sup>1</sup>Open to debate.

## Extending L<sup>A</sup>T<sub>E</sub>X

`\ce{H2O}`  $\backslash$   
`\ce{Cl-}`  $\backslash$   
`\ce{CrO4^{2-}}`  $\backslash$   
`\ce{(C3H4O2)2}`



Add the amount before the formula.

`\ce{2O2}`  $\backslash$   
`\ce{3/4Cl2}`



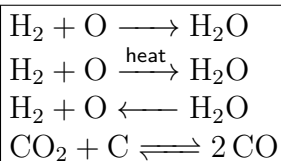
Displaying isotopes:

`\ce{^{14}_{6}C}`  $\backslash$   
`\ce{^{17}_{6}C+}`



### 11.2.2 Reactions

`\ce{H2 + O -> H2O}`  $\backslash$   
`\ce{H2 + O ->[\text{heat}] H2O}`  $\backslash$   
`\ce{H2 + O <- H2O}`  $\backslash$   
`\ce{CO2 + C <=> 2CO}`



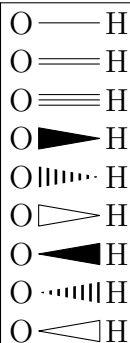
More information on mhchem can be found [here](#).

### 11.2.3 Drawing Chemical Formulae

Load the chemfig package and use `\chemfig`.

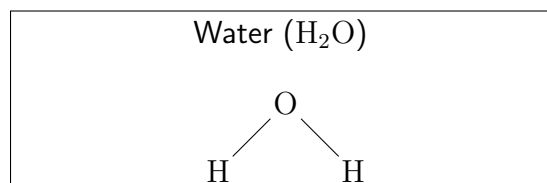
#### Bonds

`\chemfig{O - H}`  $\backslash$   
`\chemfig{O = H}`  $\backslash$   
`\chemfig{O \sim H}`  $\backslash$   
`\chemfig{O > H}`  $\backslash$   
`\chemfig{O >: H}`  $\backslash$   
`\chemfig{O >| H}`  $\backslash$   
`\chemfig{O < H}`  $\backslash$   
`\chemfig{O <: H}`  $\backslash$   
`\chemfig{O <| H}`



## Bond Angles

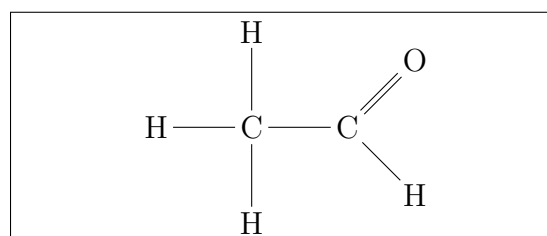
```
\centering
Water ($\ce{H2O}$) \vspace{.5cm} \\
\chemfig{H-[1] O-[7] H} \\
```



[x] represents (x \* 45)°.

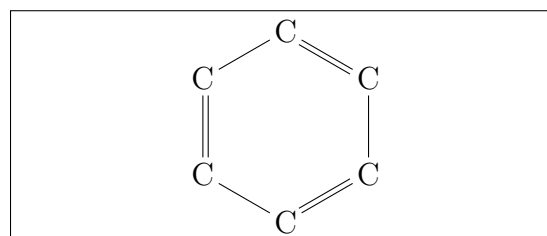
A more complex example:

```
\centering
\chemfig{H-C(-[2] H)(-[6] H)-C(=[1]
O)-[7] H}
```



## Rings

```
\centering
\chemfig{C*6(-C=C-C=C=)}
```



C is the first atom. \*6 is the number of atoms. () contains the rest of the atoms.

More information on chemfig can be found [here](#).

## 11.3 Poetry

Use the verse package.

```
\centering
\begin{verse}
Roses are Red, \\
Violets are Blue, \\
This guide with help you.
\end{verse}
```

Roses are Red,  
Violets are Blue,  
This guide with help you.



More information can be found [here](#).

## 11.4 Programming Languages

You may need to type out programming languages in L<sup>A</sup>T<sub>E</sub>X.

### 11.4.1 verbatim environment

The verbatim environment outputs text or code in monospace font.

```
\begin{verbatim}
def add(x, y):
    return x + y
\end{verbatim}
```

```
def add(x, y):
    return x + y
```

To type code inline, use `\verb`.

```
\verb|add()| returns the sum of 2
    numbers.
```

```
add() returns the sum of 2 numbers.
```

There should be no space between `\verb` and `|`. Any character except a letter or `*` can be used instead of `|` as a delimiter.

### 11.4.2 listings package

For more customization, use the listings package and the `lstlisting` environment. For example,

```
\begin{lstlisting}[language=Python, caption=Python Example]
def add(x, y):
    return x + y
\end{lstlisting}
```

produces

Listing 11.1: Python Example

```
def add(x, y):
    if x >= y:
        print(x)
    else:
        print(y)
    return x + y
```

You can also highlight code, add line numbers, and do many more things. Read [this](#) guide for more information.

Code highlighting can also be done via the `minted` package. Read about it [here](#). **Warning:** `minted` can cause errors. However, solutions to the most common errors can be found [here](#).

## 11.5 PDF Forms

Use the `Form` environment.

```
\begin{Form}[action={path/to/submit}]
\begin{tabular}{l}
  \TextField{Name} \\\
  \CheckBox[width=1em]{Male}
  \CheckBox[width=1em]{Female}
  \CheckBox[width=1em]{Other} \\\
  \Submit{Submit} \quad
  \Reset{Reset} \\
\end{tabular}
\end{Form}
```

Name

Male      Female      Other

Submit      Reset

More information can be found [here](#). A more thorough example can be found [here](#). **Warning:** making PDF forms in L<sup>A</sup>T<sub>E</sub>X can be buggy, so it's probably better to use Adobe Acrobat.

## 11.6 Emojis

### 11.6.1 Using LuaL<sup>A</sup>T<sub>E</sub>X

Use `\emoji` provided by the `emoji` package with the LuaL<sup>A</sup>T<sub>E</sub>X compiler as follows:

```
% Preamble
\usepackage{emoji}

% Body
\emoji{flexed-biceps-medium-dark-skin-tone}
```

A list of emojis provided by the `emoji` package can be found [here](#).

### 11.6.2 Using X<sub>Y</sub>L<sup>A</sup>T<sub>E</sub>X

If you need to use the X<sub>Y</sub>L<sup>A</sup>T<sub>E</sub>X compiler, [download](#) the Symbola font on your local PC and do the following:

I am `{\fontspec{Symbola}\char"1F600}!`

I am 😊!

[Here](#) is a list of emoji codes.

### 11.6.3 Using Images

Another option is to insert emojis at images. Read [this](#) article for more details.

## 11.7 Writing a CV

If you want to write your CV with L<sup>A</sup>T<sub>E</sub>X, choose one of the [templates](#) and edit accordingly. I have also uploaded a template on [GitHub](#).

## 11.8 Writing a Thesis

If you don't know how to write a thesis, read [this](#) guide. If you want to write your thesis with L<sup>A</sup>T<sub>E</sub>X, choose one of the [templates](#) and edit accordingly. If you want a video walkthrough, [these](#) are the best videos I have come across.

## 11.9 Presentations

beamer is the document class for presentations. I learnt beamer using Overleaf's [tutorials](#). You can find examples of aesthetically pleasing presentations [here](#). A list of beamer themes can be found [here](#).

# Chapter 12

## Clever Tricks

Here is a list of  $\text{\LaTeX}$  hacks:

1. `\today` - prints today's date (December 23, 2021).
2. `\TeX` - prints  $\text{\TeX}$ .
3. `\LaTeX` - prints  $\text{\LaTeX}$ .
4. **Negations** - place `n` or `\not` before a math symbol command to get its negation: `\in` prints  $\in$  and `\not\in` prints  $\notin$  (doesn't always work).
5. **One Bracket** - use `\left.` (or `\right.`) if you only need 1 delimiter: `\left.\frac{1}{2}\right)` yields  $\frac{1}{2})$ .

# Chapter 13

## Common Errors

1. **Too few braces** - `\section{I am missing a closing brace!`
2. **Too many braces** - `\section{I have an extra brace}}`
3. **Non-matching braces** - `\section[My braces don't match}`
4. **Missing environment end** - `\begin{enumerate} \item Don't forget to add \end{enumerate}`
5. **hbox errors** - read [this](#).
6. **Forgetting to use `\` to escape** - `$` does not print `$`.
7. **Forgetting to use math mode** - `a^2 + b^2 = c^2` will cause an error, but `$a^2 + b^2 = c^2$` will not (remember to place mathematical symbols, expressions, and statements in math mode).
8. **`\\` error** - if you get a “There's no line here to end” error, try `$\\$`.
9. **URL error** - if you can't open a URL, try adding `http://` or `https://`
10. **Compiler error** - If you use external packages and get an error, you may be using the wrong compiler: e.g. `fontspec` needs `XYLaTeX` or `LuaLaTeX`.
11. **Footnote / Index / References / Labels / Links not showing** - recompile the document multiple times to typeset successfully.
12. **Declaring packages in wrong order** - declare the `hyperref` package last (as it causes most of the issues). A more comprehensive list of package conflicts can be found [here](#).

# Chapter 14

## More Resources

As  $\text{\LaTeX}$  is open-source, resources are infinite. Popular resources include:

### 1. Big Resources

- [Search Engine](#) - [Google](#).
- [CTAN](#) -  $\text{\LaTeX}$ 's humble abode.
- [Stack Exchange](#) - ask questions.
- [\LaTeX Forum](#) - ask questions.
- [\LaTeX Subreddit](#) - for reddit fans.

### 2. Learn $\text{\LaTeX}$

- [Overleaf](#) - learn and write  $\text{\LaTeX}$  online (highly recommended).
- [Wikibooks](#) - a more comprehensive  $\text{\LaTeX}$  online guide (highly recommended).
- [\LaTeX Playlist](#) - learn  $\text{\LaTeX}$  on YouTube.
- [Dr Trefor Bazett](#) - learn  $\text{\LaTeX}$  from a mathematician.
- [The Art of \LaTeX](#) - book to learn  $\text{\LaTeX}$ .
- [The Not So Short Introduction to \LaTeX](#) - Bible of  $\text{\LaTeX}$ .
- [\LaTeX Gallery](#) -  $\text{\LaTeX}$  templates (highly recommended).

### 3. Cheat Sheets

- [\LaTeX Cheat Sheet](#) - 2-page cheat sheet.
- [\LaTeX Math Cheat Sheet](#) - Math cheat sheet.
- [\LaTeX Quick Guide](#) - 2-page guide.

### 4. Some Pretty Cool Stuff

- [Mathpix Snip Notes](#) - convert images and pdf documents to  $\text{\LaTeX}$ .

## More Resources

---

- [L<sup>A</sup>T<sub>E</sub>X + Vim](#) - writing L<sup>A</sup>T<sub>E</sub>X in Vim.
- [L<sup>A</sup>T<sub>E</sub>X + Notion](#) - writing L<sup>A</sup>T<sub>E</sub>X in Notion.
- [logicpuzzle](#) - create puzzles (sudoku, battleship etc.) with L<sup>A</sup>T<sub>E</sub>X.
- [For Coffee Lovers](#) - place coffee stains on L<sup>A</sup>T<sub>E</sub>X documents.
- [Even more resources](#) - an awesome list of L<sup>A</sup>T<sub>E</sub>X resources.

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