Introduction to LaTeX for physicists

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Outline

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Introduction

- This is an attempt to give you some information to **get you started** in using the LaTeX Document Preparation System.
- Further details can be obtained elsewhere, in particular from the main reference for LaTeX which is *The LaTeX User's guide and Reference Manual* by Leslie Lamport, and also from the internet resources shown at the end.
- This lecture is designed to be *introductory*.
- This presentation will be available on my website.

The big idea of LaTeX

LaTeX is a "professional typesetting system", and not a "botched together word processor".

- Rather than encourage you to dictate exactly how your document should be laid out, LaTeX instructions allow you describe its *logical structure*.
- You concentrate on the logic of your document, LaTeX can concentrate on the typesetting

The big idea of LaTeX

There are a number of good reasons for concentrating on the logical structure rather than on the appearance of a document.

- It prevents you from making elementary typographical errors in the mistaken idea that they improve the aesthetics of a document. The primary function of document design is to make documents easier to read, not prettier.
- It is more flexible, since you only need to alter the definition of some particular type of structure and this will change the appearance of all appearances of that structure in a document.

The big idea of LaTeX

Logical design encourages better writing.

- A visual system makes it easier to create visual effects rather than a coherent structure.
- Logical design encourages you to concentrate on your writing and makes it harder to use formatting as a substitute for good writing.

Advantages of using LaTeX:

- It produces beautiful results.
- It is free.
- It runs on every computer you could ever think of.
- It has been tried and tested for years.
- It typesets maths easily and cleanly.
- It's the majority-choice in the physics community.
- It emails around easily.

Advantages of using LaTeX:

- The rest of the world uses it – and they all use effectively the same version. It is 'backwards compatible'.
- You can submit your research papers to most journals electronically in LaTeX.
- You can work collaboratively 'in the cloud' with packages like Overleaf or ShareLaTeX.
- It is the best thing to do a thesis in – citations, references, and figures are all linked so that if you swap around two chapters, all the cross-references follow cleanly without you having to do anything more. It is the most logical way to write a thesis.
- Many more which I can't currently think of.

Disadvantages of using LaTeX:

- None.

Well that's not quite true, there are some disadvantages which are basically:

- It's not WYSIWIG (What You See Is What You Get) and therefore. . .
- It takes a short while to get used to . . .

but if you have more than half a brain, you have no serious alternative!

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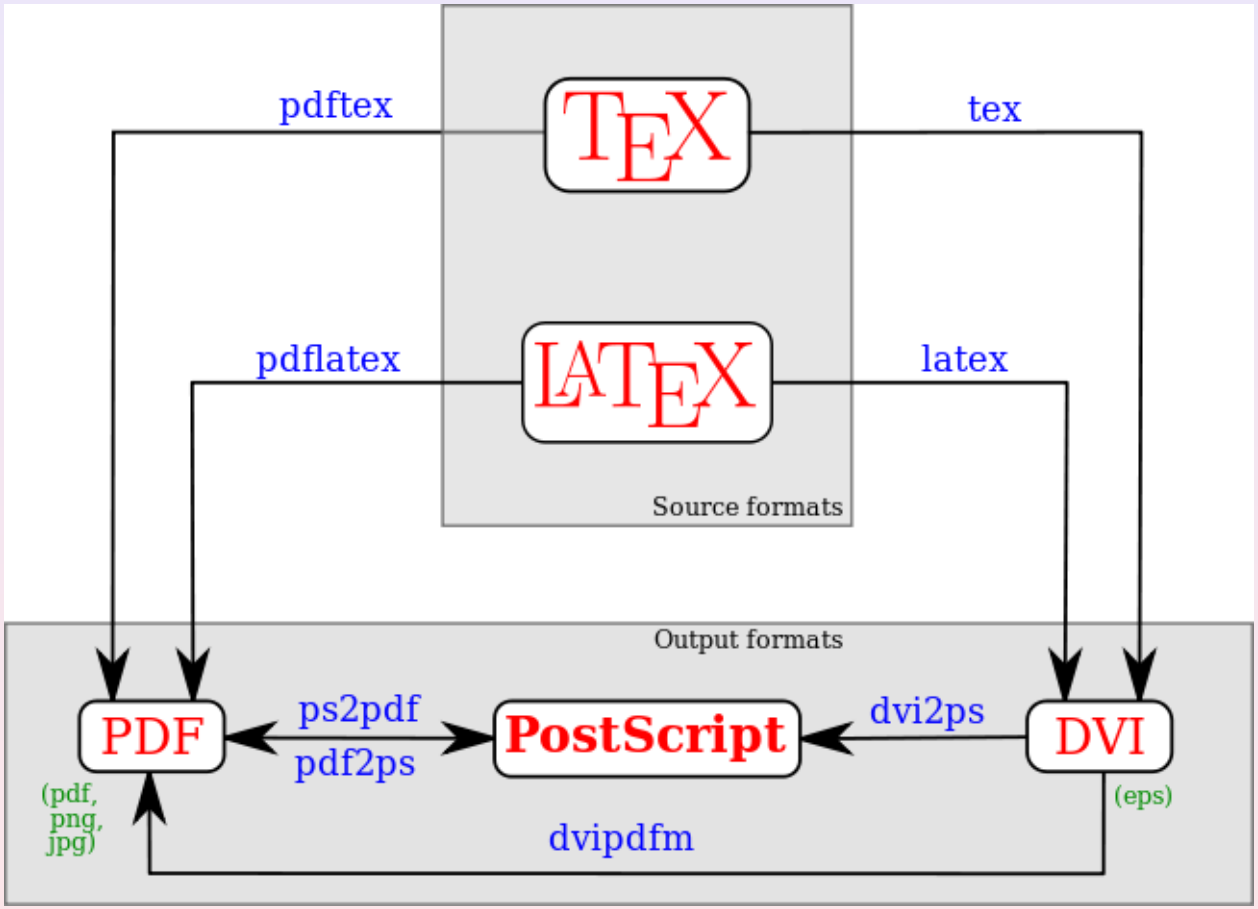
Using LaTeX

- In order to use LaTeX you have to generate a file containing both the text that you wish to print and instructions to tell LaTeX how you want it to appear.
- You will normally create this file using your system's text editor.
- It is an ASCII file. Being an ASCII file means that it doesn't contain any control characters. Therefore the text editor that you choose to use should **not** be Microsoft Word or even WordPad. These absolutely stuff every file with every control character under the sun to control all their formatting. What is more, different versions of Microsoft Word appear to be incapable of speaking to each other reliably.

Using LaTeX

- The file can have any name but should end "`.tex`" to identify the file's contents.
- LaTeX then creates a new file of typesetting commands; this has the same name as your file but the "`.tex`" ending is replaced by "`.dvi`". This stands for '*dev*ice *i*ndependent' and, as the name implies, this file can be used to create output on a range of printing devices. A `dvi` file is **not** an ASCII file and contains lots of control characters.
- The `dvi file` can be converted to PostScript (the language that laser printers talk) which is interestingly (yawn – are you still following?) also an ASCII language, so it's easy to hack (for those wishing to try). This can also be converted to a `pdf` file.

Using LaTeX



http://en.wikibooks.org/wiki/LaTeX/Introduction

Outline

First attempt

```
What I am showing here is that
the input file looks rather like
the output.  The stuff
gets
typed in in some sort of an order and the returns
go all over the place. But \LaTeX\ sorts them out.
```

this becomes:

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First attempt

```
....sorts them out.

It's {\bf only} if I leave a {\it blank} line that \LaTeX\ start
a new paragraph.  One other thing is that I
would like to define a variable called $a$ which
is given by $a=b^2+\sigma_i$ which I
have now done.
```

this becomes:

What I am showing here is that the input file looks rather like the output. The stuff gets typed in in some sort of an order and the returns go all over the place. But LaTeX sorts them out.

It's **only** if I leave a *blank* line that LaTeX starts a new paragraph. One other thing is that I would like to define a variable called a which is given by $a = b^2 + \sigma_i$ which I have now done.

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Now do some displayed equations

```
There are two types of equations.  The equations that are in the
like $E=mc^2$ like this, but also displayed equations which are
\begin{equation}
E=mc^2,
\end{equation}
and get a line to themselves.
Notice that the equation gets automatically numbered.
```

this becomes:

There are two types of equations. The equations that are in the text, like $E = mc^2$ like this, but also displayed equations which are written as

$$E = mc^2, \tag{1}$$

and get a line to themselves. Notice that the equation gets automatically numbered.

Now do some displayed equations

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$$E = mc^2, \tag{1}$$

and get a line to themselves. Notice that the equation gets automatically numbered.

Now have some fun

```
You probably noticed that superscripts go like $a^2$ and subscri
go like this $a_i$.  Note that $a^23$ works like that so if you
want to raise something to the 23rd power you should use
$a^{23}$.  In other words you put the 23 in curly brackets.
```

this becomes:

You probably noticed that superscripts go like a^2 and subscripts go like this a_i. Note that $a^2 3$ works like that so if you want to raise something to the 23rd power you should use a^{23}. In other words you put the 23 in curly brackets.

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Now have some fun

```
Consider the function
\begin{equation}
f(x) = \sum_{i=1}^N a_i^{j+k+l}.
\end{equation}
```

this becomes:

Consider the function

$$f(x) = \sum_{i=1}^{N} a_i^{j+k+l}. \tag{2}$$

Now have some fun

```
Consider the function
\begin{equation}
f(x) = \sum_{i=1}^N a_i^{j+k+l}.
\end{equation}
```

this becomes:

Consider the function

$$f(x) = \sum_{i=1}^{N} a_i^{j+k+l}. \tag{2}$$

Now have some fun

```
Consider the function
\begin{equation}
g(x) = \int_0^\infty e^{-y^2} \, dy,
\label{donkey}
\end{equation}
and I have labelled this equation which I can now refer
to as equation~\ref{donkey}.
```

this becomes:

Consider the function

$$g(x) = \int_0^\infty e^{-y^2}\, dy, \tag{3}$$

and I have labelled this equation which I can now refer to as equation 3.

Now have some fun

```
Consider the function
\begin{equation}
g(x) = \int_0^\infty e^{-y^2} \, dy,
\label{donkey}
\end{equation}
and I have labelled this equation which I can now refer
to as equation~\ref{donkey}.
```

this becomes:

Consider the function

$$g(x) = \int_0^\infty e^{-y^2}\, dy, \tag{3}$$

and I have labelled this equation which I can now refer to as equation 3.

Itemize

There are a number of rather useful environments in LaTeX for producing particular effects. They all begin with a begin and end with an end and show which kind of environment they are.

```
Items in a list:
\begin{itemize}
\item Feed the cat
\item Hug a tree
\end{itemize}
```

this becomes:

Items in a list:

- Feed the cat
- Hug a tree

Itemize

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```

this becomes:

Items in a list:

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- Hug a tree

Enumerate

```
\begin{enumerate}
\item Here is one.
\item It's good for making lists.
\item If you like numbered lists.
\end{enumerate}
```

this becomes:

1. Here is one.
2. It's good for making lists.
3. If you like numbered lists.

Enumerate

```
\begin{enumerate}
\item Here is one.
\item It's good for making lists.
\item If you like numbered lists.
\end{enumerate}
```

this becomes:

1. Here is one.
2. It's good for making lists.
3. If you like numbered lists.

Center

```
And also
\begin{center}
For making something {\bf centred}.
\end{center}
```

this becomes:

And also

For making something **centred**.

Note the US spelling!

Center

```
And also
\begin{center}
For making something {\bf centred}.
\end{center}
```

this becomes:

And also

For making something **centred**.

Note the US spelling!

Quote

```
There is rather a nice effect you can use if
\begin{quote}
‘‘You would like to say something
in poetry, maybe quoting something that somebody
said to you that you thought was worth repeating.
Oh why oh why am I typing this drivel?’’
\end{quote}
```

this becomes:

There is rather a nice effect you can use if

> *“You would like to say something in poetry, maybe quoting something that somebody said to you that you thought was worth repeating. Oh why oh why am I typing this drivel?”*

Quote

```
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\begin{quote}
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\end{quote}
```

this becomes:

There is rather a nice effect you can use if

> *“You would like to say something in poetry, maybe quoting something that somebody said to you that you thought was worth repeating. Oh why oh why am I typing this drivel?”*

Eqnarray

```
Another useful trick is that of having a set of equations
that line up, as in
\begin{eqnarray}
   f(x) & = & \sqrt{g(x)}  ,  \\
   g(x) & = & e^{-h(x)}   ,   \\
   h(x) & = & \alpha_\nu \xi_\psi (\eta_\beta ) .
\end{eqnarray}
```

this becomes:

Another useful trick is that of having a set of equations that line up, as in

$$f(x) = \sqrt{g(x)}, \tag{4}$$
$$g(x) = e^{-h(x)}, \tag{5}$$
$$h(x) = \alpha_\nu \xi_\psi (\eta_\beta). \tag{6}$$

Here note that you use the & characters to indicate what you want to line up.

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Here note that you use the & characters to indicate what you want to line up.

You actually do need some stuff at the beginning and end of your document to tell LaTeX what sort of a document this is. It might look like magic at the moment, but it does the job. A simple example is the following:

```
\documentclass[12pt]{report}
\begin{document}
A terribly simple document.
\end{document}
```

The first-line says what size point you want in general, and that the document is a report. This controls the way that section headings and other things work.
This file produces a single page with the words:

A terribly simple document.

on it.

A much more exotic example is the following:

```
\documentclass[aps,prb,superscriptaddress,twocolumn,floatfix]{revtex4}
\usepackage{graphicx}
\usepackage[]{amsmath}
\begin{document}
\title{My paper}
\author{My name}
\affiliation{Clarendon Laboratory, University of Oxford, Parks Road, Oxford OX1 3PU, United Kingdom}
\begin{abstract}
This is my paper
\end{abstract}
\maketitle
A whole bunch of stuff. In this paper we refer to \cite{nernst}.
\begin{thebibliography}{**}
\bibitem{nernst}
M. S. Nam, A. Ardavan, S. J. Blundell and J. A. Schlueter,
Nature {\bf 449}  584,  (2007).
\end{thebibliography}
\end{document}
```

which would be a starting point for writing a paper for *Physical Review* using the `revtex` macros If this file were to be processed it would produce something looking just like a real paper. If you want to do this, as with *most* things in LaTeX, the easiest way to start is to edit someone else's document! Don't reinvent the wheel. See examples on `arXiv.org`

Class files

- LaTeX can input lots of different 'class files' for setting up documents to have various different standard formats.
- These typically have the extension `.sty` for document-styles (an older version) and `.cls` for document-classes. If you want to make your document look a particular way, then you will need to get the relevant class files.
- Some, like `article.cls` come with LaTeX. Others, like `revtex4.cls`, the *Physical Review* macros may need to be downloaded from a web site or taken from someone's computer. Please ask around!

Errors

- If you have written junk in your file, LaTeX may give you some error messages. It usually tells you which line the error is in. It also usually gives you some options, of which the best ones to use are either 'H' (give me some more help), or 'X' (quit and I'll go and edit my file and sort the problem out).
- It may take a while to get used to some of LaTeX's error messages – but after a bit of practice it will come naturally. It is usually a good idea to keep LaTeXing the document regularly as you write it.
- Typing in 200 pages and then expecting it to work first time is perhaps asking a bit much. Build it up slowly and check each new bit of text. Computers are so fast now that this is not really a problem.

Do it **twice**!

LaTeX needs to process your file twice. This is because on the first sweep it loads all your cross-references, and the second time it puts them all in properly. Therefore you need to LaTeX the document twice.

Outline

A bit of history

- LaTeX was written 'on top of' a program called TeX, which is harder to program in and is now not used as much, but you may come across it.
- LaTeX was for many years standardised on version 2.09. In 1993, a new version LaTeX2e appeared which is almost the same but uses `documentclass` rather than `documentstyle`. It is backwards compatible so the old files still work.
- In the future, LaTeX3 will appear. The idea is that the version number is tending aymptotically towards π. [NB this is not a joke!]

Typefaces

`\rm`	Roman
`\it`	*Italic*
`\bf`	**Boldface**
`\sl`	*Slanted*
`\sf`	Sans serif
`\sc`	Small Caps
`\tt`	`Typewriter`

LaTeX environments

abstract	figure	quote
array	flushleft	tabbing
center	flushright	table
description	itemize	tabular
displaymath	list	theorem
enumerate	math	titlepage
eqnarray	minipage	verbatim
equation	picture	verse
	quotation	

Text-mode accents

ò	\‘{o}	ō	\={o}	o͡o	\t{oo}
ó	\’{o}	ȯ	\.{o}	o̧	\c{o}
ô	\^{o}	ŏ	\u{o}	ọ	\d{o}
ö	\"{o}	ǒ	\v{o}	o̲	\b{o}
õ	\~{o}	ő	\H{o}		

National symbols

œ	\oe	å	\aa	ł	\l
Œ	\OE	Å	\AA	Ł	\L
æ	\ae	ø	\o	ß	\ss
Æ	\AE	Ø	\O		

Miscellaneous symbols

†	\dag	§	\S	©	\copyright
‡	\ddag	¶	\P	£	\pounds

Math-mode accents

$\hat{a}$	\hat{a}	$\dot{a}$	\dot{a}
$\check{a}$	\check{a}	$\ddot{a}$	\ddot{a}
$\tilde{a}$	\tilde{a}	$\breve{a}$	\breve{a}
$\acute{a}$	\acute{a}	$\bar{a}$	\bar{a}
$\grave{a}$	\grave{a}	$\vec{a}$	\vec{a}

Greek letters (math mode)

α	\alpha	ν	\nu
β	\beta	ξ	\xi
γ	\gamma	o	o
δ	\delta	π	\pi
ϵ	\epsilon	ρ	\rho
ζ	\zeta	σ	\sigma
η	\eta	τ	\tau
θ	\theta	υ	\upsilon
ι	\iota	ϕ	\phi
κ	\kappa	χ	\chi
λ	\lambda	ψ	\psi
μ	\mu	ω	\omega

Greek letters (math mode)

ε	\varepsilon	ς	\varsigma
ϑ	\vartheta	φ	\varphi
ϱ	\varrho		

Γ	\Gamma	Σ	\Sigma
Δ	\Delta	Υ	\Upsilon
Θ	\Theta	Φ	\Phi
Λ	\Lambda	Ψ	\Psi
Ξ	\Xi	Ω	\Omega
Π	\Pi		

Binary operations (math mode)

$\pm$	\pm	$\cap$	\cap
$\mp$	\mp	$\cup$	\cup
$\setminus$	\setminus	$\uplus$	\uplus
$\cdot$	\cdot	$\sqcap$	\sqcap
$\times$	\times	$\sqcup$	\sqcup
$*$	\ast	$\triangleleft$	\triangleleft
$\star$	\star	$\triangleright$	\triangleright
$\diamond$	\diamond	$\wr$	\wr
$\circ$	\circ	$\bigcirc$	\bigcirc
$\bullet$	\bullet	$\bigtriangleup$	\bigtriangleup
$\div$	\div	$\bigtriangledown$	\bigtriangledown
$\lhd$	\lhd	$\rhd$	\rhd
$\vee$	\vee	$\odot$	\odot
$\wedge$	\wedge	$\dagger$	\dagger
$\oplus$	\oplus	$\ddagger$	\ddagger
$\ominus$	\ominus	$\amalg$	\amalg
$\otimes$	\otimes	$\unlhd$	\unlhd
$\oslash$	\oslash	$\unrhd$	\unrhd

Relational symbols (math mode)

$\leq$	\leq	$\geq$	\geq
$\preceq$	\preceq	$\succeq$	\succeq
$\prec$	\prec	$\succ$	\succ
$\ll$	\ll	$\gg$	\gg
$\subset$	\subset	$\supset$	\supset
$\subseteq$	\subseteq	$\supseteq$	\supseteq
$\sqsubset$	\sqsubset	$\sqsupset$	\sqsupset
$\sqsubseteq$	\sqsubseteq	$\sqsupseteq$	\sqsupseteq
$\in$	\in	$\ni$	\ni
$\vdash$	\vdash	$\dashv$	\dashv
$\smile$	\smile	$\mid$	\mid
$\frown$	\frown	$\parallel$	\parallel
$\neq$	\neq	$\perp$	\perp
$\equiv$	\equiv	$\cong$	\cong
$\sim$	\sim	$\bowtie$	\bowtie
$\simeq$	\simeq	$\propto$	\propto
$\asymp$	\asymp	$\models$	\models
$\approx$	\approx	$\doteq$	\doteq
		$\Join$	\Join

Variable-size symbols (math mode)

$\sum$	$\sum$	\sum	$\bigcap$	$\bigcap$	\bigcap
$\prod$	$\prod$	\prod	$\bigcup$	$\bigcup$	\bigcup
$\coprod$	$\coprod$	\coprod	$\bigsqcup$	$\bigsqcup$	\bigsqcup
$\int$	$\int$	\int	$\bigvee$	$\bigvee$	\bigvee
$\oint$	$\oint$	\oint	$\bigwedge$	$\bigwedge$	\bigwedge
$\bigodot$	$\bigodot$	\bigodot	$\bigotimes$	$\bigotimes$	\bigotimes
$\bigoplus$	$\bigoplus$	\bigoplus	$\biguplus$	$\biguplus$	\biguplus

Delimiters

(	(	)	)
[	[	]	]
{	\{	}	\}
⌊	\lfloor	⌋	\rfloor
⌈	\lceil	⌉	\rceil
⟨	\langle	⟩	\rangle
/	/	\	\backslash
|	\vert	‖	\Vert
↑	\uparrow	⇑	\Uparrow
↓	\downarrow	⇓	\Downarrow
↕	\updownarrow	⇕	\Updownarrow

"Log-like" functions (math mode)

```
\arccos   \csc    \ker      \min
\arcsin   \deg    \lg       \Pr
\arctan   \det    \lim      \sec
\arg      \dim    \liminf   \sin
\cos      \exp    \limsup   \sinh
\cosh     \gcd    \ln       \sup
\cot      \hom    \log      \tan
\coth     \inf    \max      \tanh
```

```
Compare $sin^2x+cos^2x=1$ with $\sin^2x+\cos^2x=1$.
```

produces: Compare $sin^2x + cos^2x = 1$ with $\sin^2 x + \cos^2 x = 1$.

Arrow symbols (math mode)

$\leftarrow$	\leftarrow	$\longleftarrow$	\longleftarrow
$\Leftarrow$	\Leftarrow	$\Longleftarrow$	\Longleftarrow
$\rightarrow$	\rightarrow	$\longrightarrow$	\longrightarrow
$\Rightarrow$	\Rightarrow	$\Longrightarrow$	\Longrightarrow
$\leftrightarrow$	\leftrightarrow	$\longleftrightarrow$	\longleftrightarrow
$\Leftrightarrow$	\Leftrightarrow	$\Longleftrightarrow$	\Longleftrightarrow
$\mapsto$	\mapsto	$\longmapsto$	\longmapsto
$\hookleftarrow$	\hookleftarrow	$\hookrightarrow$	\hookrightarrow
$\leftharpoonup$	\leftharpoonup	$\rightharpoonup$	\rightharpoonup
$\leftharpoondown$	\leftharpoondown	$\rightharpoondown$	\rightharpoondown
$\rightleftharpoons$	\rightleftharpoons	$\leadsto$	\leadsto
$\uparrow$	\uparrow	$\Updownarrow$	\Updownarrow
$\Uparrow$	\Uparrow	$\nearrow$	\nearrow
$\downarrow$	\downarrow	$\searrow$	\searrow
$\Downarrow$	\Downarrow	$\swarrow$	\swarrow
$\updownarrow$	\updownarrow	$\nwarrow$	\nwarrow

Misc. symbols (math mode)

$\aleph$	\aleph	$\prime$	\prime
$\hbar$	\hbar	$\emptyset$	\emptyset
$\imath$	\imath	∇	\nabla
$\jmath$	\jmath	$\surd$	\surd
ℓ	\ell	$\top$	\top
$\wp$	\wp	$\bot$	\bot
$\Re$	\Re	$\|$	|
$\Im$	\Im	$\angle$	\angle
∂	\partial	$\triangle$	\triangle
∞	\infty	$\backslash$	\backslash
$\Box$	\Box	$\Diamond$	\Diamond
$\forall$	\forall	$\sharp$	\sharp
$\exists$	\exists	$\clubsuit$	\clubsuit
$\neg$	\neg	$\diamondsuit$	\diamondsuit
$\flat$	\flat	$\heartsuit$	\heartsuit
$\natural$	\natural	$\spadesuit$	\spadesuit
$\mho$	\mho		

Common error 1

Don't put a blank line after your equation or LaTeX will think you are starting a new paragraph

```
This can be illustrated using the equation
\begin{equation}
f=ma,
\end{equation}

where following the equation there is an ugly indent.
```

This can be illustrated using the equation

$$f = ma, \tag{7}$$

where following the equation there is an ugly indent.

Common error 1

Don't put a blank line after your equation or LaTeX will think you are starting a new paragraph

```
This can be illustrated using the equation
\begin{equation}
f=ma,
\end{equation}
where following the equation there is an ugly indent.
```

This can be illustrated using the equation

$$f = ma, \tag{8}$$

where following the equation there is an ugly indent.

Common error 2

The letters in chemical formulae should not be in maths mode.

```
Water is H$_2$O and not $H_2O$.
```

Water is H_2O and not H_2O.

Common error 3

Physical quantities have a unit associated with them, and this should have a small space between the number and the unit. If you use a LaTeX space, it stops the line breaking between the number and the unit.

```
The car was travelling at 26\,m\,s$^{-1}$.
```

The car was travelling at $26\,\mathrm{m}\,\mathrm{s}^{-1}$.

Common error 4

It is very important to make even your displayed equations part of a sentence, which means punctuating them. For example, Newton's second law can be stated as

$$f = ma, \tag{9}$$

which I terminated with a comma because I was still continuing my sentence. On the other hand, I will finish this sentence, and use a full-stop, by remarking that Einstein is best known for his equation

$$E = mc^2. \tag{10}$$

Do read what you've written, even when you're discussing maths, and see if your sentences work!

Common error 5

```
Just be a bit careful when you cut and paste from other
applications. I have just pasted in the phrase
(Schrödinger equation),
but I think \LaTeX\ won't get the 'o umlaut' right.
I should use Schr\"odinger.
```

Just be a bit careful when you cut and paste from other applications. I have just pasted in the phrase (Schrdinger equation), but I think LaTeX won't get the 'o umlaut' right. I should use Schrödinger.

Common error 6

LaTeX knows four kinds of dashes: a hyphen (-), en dash (–), em dash (—), or a minus sign (−). You can access three of them with different numbers of consecutive dashes. The fourth sign is actually not a dash at all; it is the mathematical minus sign:

```
hyphen: daughter-in-law, X-rated\\
En dash: pages 13--67\\
Em dash: yes---or no? \\
Minus sign: $0$, $1$ and $-1$
```

hyphen: daughter-in-law, X-rated
En dash: pages 13–67
Em dash: yes—or no?
Minus sign: 0, 1 and −1

Common error 7

LaTeX treats left and right quotes as different entities. For single quotes, ‘ gives a left quote mark, and ’ is the right.

```
You can use ‘single’ or ‘‘double’’ or ‘‘double" but
{\bf not} ’this’ or "that".
```

You can use ‘single’ or “double” or “double” but **not** ’this’ or ”that”.
(As you can see, we have now descended into the depths of pedantry!)

Internet resources

And finally...

`http://www.latex-project.org/`

`http://en.wikibooks.org/wiki/LaTeX`

are both really helpful. Another resource which could be useful is

`http://detexify.kirelabs.org`

which allows you to find a symbol by drawing it.

Internet resources

For Linux users, install the `tetex` package (should already be installed). The same is true for the Mac, on which you can use X11 from the command line. There is also TeXShop and TeXworks. See also the MacTeX project:

`http://www.tug.org/mactex/`

For the PC, the most popular implementation seems to be

`http://www.miktex.org/`

Internet resources

For collaborative working, try the excellent Overleaf:

`https://www.overleaf.com`

or ShareLaTeX:

`https://www.sharelatex.com`

[NB ShareLaTeX is soon going to merge into Overleaf.] Your files then sit in the cloud, but you can work on a project with someone else and have features like version control. These implementations are then platform independent.

IN CONCLUSION

HAVE A GO YOURSELF!

Try it out on whatever system you wish to use. Ask people in your group for help and give it a go.