An Example LaTeX File for PHYS 2380

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Abstract

Often LaTeX is used to typeset scientific papers for submission to a journal, but any case where similar formatting is needed, such as lab reports or a thesis project. The benefit to LaTeX comes from the ease of typsetting mathematics that the language provides. Here, I've set up an abstract that is meant to give a brief overview of your work and briefly summarize your results.

1 Introduction

The LaTeX language is extremely useful in typesetting documents that contain a lot of mathematics. This language requires text to be entered into a suitably formatted document, which is compiled like a computer code (for example, C or FORTRAN). The compilation of this document produces a number of output files that can be converted into a PDF file without too much trouble. This can be done through the use of a GUI based editor (such as TeXworks or WinEDT), or from the command line using MiKTeX directly, if you prefer.

Regardless of this choice, let's now see how mathematics can be written in a LaTeX file. Consider the following (relevant) equation, $p = \hbar k$. Any time we want to include math in a section of text, just put it inside dollar signs and LaTeX will interpret the symbols in "math mode". Anything within these dollar signs will be interpreted as LaTeX code and will be accordingly typeset by substituting the actual symbols for the LaTeX tags that are denoted by a `\`, for example `\alpha` produces an α. It's easy to include any combination of mathematical symbols that you might be interested in.

For more complicated equations, it's better to give the equation it's own line and number. For this you can use the "equation environment". To do this, just get to a new line and enter your desired equation between `\begin{equation}` and `\end{equation}` (see the .tex file for details):

$$p = \hbar k = \frac{h}{\lambda}. \tag{1}$$

This equation will be nicely formatted and centered in the PDF document and labelled. Note that within the equation environment, I defined the label `\label{eqnp}`. This label now points to this equation throughout this text. We can refer to the equation anywhere in the manuscript easily just by referencing this unique label, like this: `\ref{eqnp}`. Once this is compiled, it will produce the same number as the equation where we defined the label `eqnp`, for example equation 1. You can make the tag whatever you like for a given equation and reference it just as easily. For example, let's look at another relevant equation, which will give the energy of a particle E in terms of an angular wave frequency ω:

$$E = \hbar\omega = h\nu = \frac{hc}{\lambda} \tag{2}$$

and now I can reference this equation, which is equation 2 anywhere in the text that I like.

The utility of this is clear for more complicated expressions too. Later on in the course we will make use of some identities that make good LaTeX examples. When we use the equation environment below, note the use of underscores (`_`) for subscripts and hats (`^`) for superscripts. We also put symbols under a square root sign and use infinity symbols in this expression too:

$$\int_{-\infty}^{\infty} e^{-x^2} dx = \sqrt{\pi} \tag{3}$$

And let's do another one that may be useful in the future too. This time let's make the exponential look a bit nicer.

$$\int_{-\infty}^{\infty} x^2 \exp\left(-x^2\right) dx = \frac{1}{2}\sqrt{\pi} \tag{4}$$

Let's give one more example of formatting LaTeX equations. One of the main results we'll see in PHYS 2380 is the Schrödinger equation, along with a variety of solutions to it (note that many accents are also included in LaTeX, such as the umlaut in Schrödinger which is accessed by `{\"o}`. Schrödinger's equation is

$$-\frac{\hbar^2}{2m}\nabla^2\psi\left(\mathbf{x}\right) + V\left(\mathbf{x}\right)\psi\left(\mathbf{x}\right) = E\psi\left(\mathbf{x}\right) \tag{5}$$

I used a bold x to show a vector quantity, but I also could have used a $\vec{x}$ just as easily.

Now let's also cite this result. In the bibliography below I give an example of how to include a reference. This has a tag within curly braces, ie `{schroEqn}`. Now anywhere in the text I write `\cite{schroEqn}` I will point back to this reference. For example, Schrödinger first published his equation in 1926 [1].

2 We can typeset matrices too!

Matrices are also fairly easy to make in LaTeX. To write a matrix we need to set up a small table to contain the matrix elements within the equation

Figure 1: Erwin Schrödinger himself loved using LaTeX, evidenced by this picture taken after he compiled his first LaTeX document successfully.

environment that we made so much use of in Section 1. We do this using the following example. Let's also pick a nice aesthetically pleasing matrix. For example, a magic square is defined as a matrix of integers ranging from 1 to N^2 where N is the size of the matrix which has constant sums along all rows, columns, and body diagonals. The smallest magic square I can write is a 3×3 (or $N = 3$),

$$M = \begin{bmatrix} 8 & 1 & 6 \\ 3 & 5 & 7 \\ 4 & 9 & 2 \end{bmatrix} \tag{6}$$

As we can see from the matrix M in equation 6, the rows sum to the same value $8+1+6 = 3+5+7 = 4+9+2 = 15$ as well as the columns $8+3+4 = 1+5+9 = 6+7+2 = 15$ and the main diagonals too $4+5+6 = 8+5+2 = 15$. For an example of magic squares in an undergraduate physics problem, see the paper by Loly [3].

References

[1] Erwin Schrödinger (1926). An Undulatory Theory of the Mechanics of Atoms and Molecules *Physical Review*, 28 (6), 1049-1070.

[2] Actually, Schrödinger never used LaTeX. He was just laughing about cats on the internet.

[3] Peter D. Loly (2004). The Invariance of the Moment of Inertia of Magic Squares *The Mathematical Gazette*, 88 (511), 151-153.