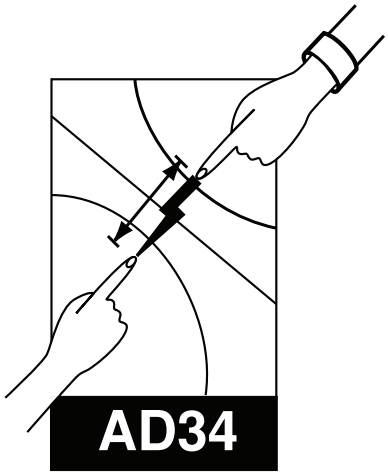
Writing scientific reports



JB April 2022

1 Report writing in the Oxford Physics degree

Accurately communicating work so that it can be understood, discussed, reproduced and continued is a vital skill for any scientist. In the final year of your degree, you will also need to write a report for either an MPhys or BA project which will count for a significant part of your final degree mark. This document assists you in learning how to present scientific experiments and results, either as part of your degree or for research purposes.

2 Introduction

Physics relies on experiments to test theories and models of physical phenomena. Write-ups of these experiments should provide enough information for a reader to understand the aims and outcomes of the experiment, the approach taken, the measurements made, the analysis conducted and the results obtained. The language used should be precise wherever possible, with the data and analysis presented in a manner that allows the reader to evaluate the significance of the results. Scientists publish their write-ups (called papers) in peer reviewed journals (e.g. Applied Physics Letters, Physical Review A) or conference proceedings and future scientific careers can be shaped by the number of papers published and the types of journals which the papers are published in. It is therefore important, as part of your scientific training, to learn how to write papers and reports which could then be published.

Within your Physics degree at Oxford, we ask you to write a number of reports as part of this learning process. This document provides guidance on how to structure the reports and how to avoid the common mistakes which students can make with their reports. Please read all the way to the end of this document and make use of the example reports which we will provide.

3 Overall comments

When writing any report or scientific paper, make sure you know who your audience is. All reports written as part of the Oxford Physics degree should be written at a level understandable by another physicist in your year, someone who has **not** done the experiment/practical/project but knows basic physics. The person who marks your BA, MPhys or B8/B9 project work is also not likely to be a specialist in that field so you need to make sure the report is written at a suitable level. However, if you were writing a research paper, then you would assume that your audience is someone familiar with the general area being discussed and you might write at a different level.

Reports which you write as part of your degree should be self-contained and structured so that it is easy to follow. A standard approach is to break the report into a number of sections with clear headings as detailed in the next section. You can use bold fonts, underlining, numbered lists and bullet points to make the report easier to follow but do try and write in complete full sentences. You should not reproduce large chunks of text or equations from other sources. Ensure that you reference the script (for lab write-ups) and any other sources (see section 6) which you used when writing the report. The

Copyright © 2023 University of Oxford, except where indicated.

validity of an experimental outcome depends critically on the uncertainties associated with your work, so it is important to discuss these within your report.

Good reports will use both passive and active voice. The active voice is direct, clear and concise. The passive voice is indirect, but useful to emphasise the research, rather than the researcher. This is most applicable to the method section of scientific reports as well as the parts of the introduction dealing with theoretical background. The active voice is suitable where the action or judgement of the researcher should be the focus. This is likely to be appropriate in the abstract and conclusion as well as parts of the introduction where the researcher's hypothesis or assumption are laid out.

Well-chosen and clearly constructed figures are essential in a scientific report. Frequently, readers may first look at the abstract and conclusion and then look immediately at the figures, which should provide the essential evidence for the hypothesis and the conclusion of the report. Figures you might include could be a schematic or photo of an experimental setup, an illustration of the flow in a computer program or the results obtained. All figures need a figure caption which should begin with a short descriptive statement of the entire figure followed by additional text, e.g. "Figure 1: Amplitude of the torsional pendulum oscillation as a function of driving frequency for the case of heavy damping. The red line is a damped sine function fit to the data." Make sure all figures are large enough and lines and data points are clearly labelled, including a legend if you have multiple line types. Figures should be sized to make the optimum use of space available and proportioned according to the importance of the figure in the paper, and all numbers on axes must be legible.

It is important to compare your results with those in the literature. Demonstrators will be able to help you to locate e.g. the paper or book which reports the most accurate and recent value of a physical constant that you have attempted to measure, or you can try to find more background information online or in a library (see also AD15 — *Information sources in physics*[1]). It is best to obtain this information at the same time as you do the experiment. Remember that the labs are closed and demonstrators may not be available when reports are written. For this reason you should also make sure that the data you need is somewhere you can access it subsequently, so not stored on the hard drive of a lab computer.

For reports you will write within the Physics Degree please note the following overall requirements:

- No less than 11 point, fully justified text in main body of report
- Single or multiple columns per page can be used
- Figure captions and table headings should be no less than 8 point
- Minimum margins of 2cm
- Page limit includes abstract and references
- Page limit excludes appendices
- Any word processing package can be used (e.g. Word, Latex or something else)
- Reports exceeding the maximum page limit will be marked down

Details of the page limits for each of the different reports in the Physics degree are given on the next page.

[1] `www-teaching.physics.ox.ac.uk/practical_course/Admin/AD15.pdf`

Report	Page limit	Included in final degree mark?	Notes
1st year optics	5 pages	No	
1st year general physics	5 pages	No	
1st year computing summary (CO6x)	2 pages	No	You must include your code in an appendix, which is not included in the page limit
2nd year computing	8 pages	No	You must include your code in an appendix, which is not included in the page limit
3rd year mini project	10 pages	Yes	Marked by college tutor, can have comments on one draft
Vacation report (optional, 2nd / 3rd year only)	6 pages	No	Front of report should show candidate number rather than student name
Report on extended practical (optional, 2nd or 3rd year only)	6 pages	Yes	Front of report should show candidate number rather than student name
Report on extra practical work to substitute for short option (optional, 2nd or 3rd year only)	6 pages	Yes	Front of report should show candidate number rather than student name
B8 or B9 project report (optional, 3rd year only)	10 pages	Yes	More guidance on this report is given in a specific talk in year 3 and on Canvas. Front of report should show candidate number rather than student name
MPhys/BA project report	10 pages	Yes	More guidance on this report is given in a specific talk in year 3 or 4 and on Canvas. Front of report should show candidate number rather than student name

4 Structure

Scientific reports often take a structure similar to that described below and followed in the template we provide. Particular care should be given to the abstract and conclusion as well as the clarity and quality of the figures. Make sure they are clear in any report or paper which you write.

Header and Footer The information required varies depending on the type of report. First year lab reports usually need your name on them, whereas if a report is submitted for examination you must NOT put your name on it, to allow anonymous marking. Please also include page numbers on each page of the report. The information required for each report is contained within the template we provide.

Title A sentence describing the measurement(s)

Abstract The abstract should be no more than 200 words, typically around 125 words. Make sure the content of the abstract matches the content of the report – sometimes you only write the abstract when you have finished the rest of the report. It should be a single paragraph and should include any key results.

Introduction This should be a few paragraphs summarising the motivation, aims and context of the experiment. Why is the physics you are discussing interesting? Does it have wider significance in terms of technological applications? Finally, the introduction explains the paper's layout.

Methods Depending on the work you are writing up this can include a description or diagram of the apparatus used (including any particular problems or issues that arose), derive, explain, or at least mention all the theoretical formulae used later in the report and/or the numerical approach

you have taken to solve the problem and turn the equations into computer code, including any simplifications or assumptions you made. You do not need to follow the lab script and answer every question; instead think about the overall objectives of the experiment or the part of the experiment which you are writing up and focus on these.

Results and Analysis This section should contain the results obtained and the manipulation of your data to provide the information you need. Think about the best way to present the data - it might be a table or a graph but probably not both. The analysis should include estimates of uncertainties and may require propagation of error calculations. There can be several sources of error in a numerical or actual experiment and these should be taken into account in producing the final answer and its error. For some experiments it may make more sense to have a Method and Analysis/Results section for each different aspect of the experiment rather than writing a long Method and then a long Results section. You should draw some conclusions on your results in this section and compare them to other values which might have been expected or reported elsewhere.

Conclusion Summarise the report including the aims of the experiment/work, results obtained and comparison to other results or theoretical predictions. This section should not contain any new results or conclusions which you haven't covered elsewhere. If further measurements or future work would be useful, indicate that in this section. This should be no more than 2 paragraphs in length.

References This records sources of information, theory or previous studies. References can be papers, textbooks, webpages or lab scripts. A report should contain at least two references, complete with URL if appropriate so that the reader may check where information has come from. References are included in the page limit for reports.

Appendix / Appendices This contains programs, derivations etc. which are too detailed to include in the main text (although you should avoid including excessive amounts of material). These are not usually read by the marker and are not included in the page limit. For Part A computing reports, you must include the computer code in an appendix at the end of the report.

Sections and subsections should be numbered, as should equations, tables and figures. This makes it much easier for the reader to find information. For example, you might want to write "Applying equation 59 (see section 4.3) to the data in figure 12 produces the fit parameters shown in table 9".

Note that different journals make use of different templates or have different authoring advice. The advice contained here therefore represents a good start but if you were writing a paper for a specific journal you would need to adapt the layout to the structure required for that specific journal. It is worth looking at the latest copy of a Physics journal (e.g. Physical Review A) to get an idea of what a paper looks like as this might help you see what we are trying to train you to produce by the end of your degree. You can find journals using links on this page: `https://www.bodleian.ox.ac.uk/collections-and-resources/books-and-journals`.

5 Common mistakes students make in reports

Writing reports during your degree is a journey - few students get it right the first time but you should learn from the feedback you receive to make the next one better. This will mean that when you write reports which count towards your final degree mark, you can produce an excellent piece of work which is not marked down to excessive page length or poor structure. Below we list the common mistakes students make, especially in their first few reports.

- Missing or poor figure and table captions: it is very common for students to put in a table or figure but forget to include a caption or write a poor caption. Figure captions go below the Figure, Table captions go above the Table. Make sure the caption tells the reader everything they need to know without reading the rest of the report, e.g. "Graph of x against y" is poor, "Graph of Period of pendulum in seconds against length of string in cm" would be a better caption. Make sure you use clearly labelled column headings in all tables.

- Figure or table not referenced in text: students can sometimes include a figure or table but it is not referenced anywhere within the text, so you really don't know why it is there. If you don't need to refer to it, either remove it or put it in an appendix.
- Problems with graphs: all graphs must contain labelled axes (including units), a title and a legend if they contain more than one set of data. Make sure all graphs are large enough and you can distinguish between different line types or data symbols.
- Equations not numbered or variables not defined: if you include an equation make sure you define all the variables contained in it and that you number the equations.
- Too many equations: your report does not have to contain a full derivation of a particular result if that is easily found elsewhere. For example, it is better to write "the full derivation of the final result, assuming a small angle approximation can be found in [1], so I will just give the final result here" where [1] would be the lab script or a textbook. Only include the most relevant equations - be selective!
- Figures, text or equations taken from elsewhere are not correctly referenced: make sure anything taken from another source (e.g. lab script, textbook, online) are correctly referenced. Failure to do so is plagiarism. See section 6 for more details.
- Missing errors or percentage errors: any number without an error is meaningless so make sure every number contains an error. Don't use percentage errors, use the actual value, e.g. don't use "the length was 54.2 mm $\pm$ 7%", write "the length was 54.2 $\pm$ 3.8 mm"
- Italic units: when writing a value, make sure you use SI units (or whatever unit is normally used in the field, e.g. Angstroms in visible optics) and don't italicise the units e.g. do not write "the mass was $(1100 \pm 500)\ g$", write "the mass was (1100 ± 500) g".
- Same data in both a Table and Figure: don't give both a table of data and a figure showing the same information. You don't usually need both so pick whichever makes it the easiest to understand the data. You can always add lots of actual data at the end of the report in an appendix if it is really necessary.
- Too long: make sure you know what the maximum page limit is for the report you are writing and do not exceed it. The abstract, method, results, analysis, conclusions and references are all included in the page limit. Any appendices you include are not included in the page limit. If you exceed the page limit you will be marked down so you need to be selective and potentially not include everything!

6 Referencing

When writing a report, it is important to state clearly which parts represent your own work and which parts are derived from other sources. It is not acceptable to just say "It is well known that…"; such statements must be backed up with a reference. For example:

"The data in the present report suggest a value of $g = 2.004 \pm 0.001$, which compares well with the study of Grollick et al. [24] who obtained $g = 2.00 \pm 0.01$. Earlier work [25,26] produced much lower values ($g \sim 1.8$); such underestimates are now known to be due to neglect of the double-zeta basis function [27]…"

Here the numbers refer to literature listed in the references. Typical references for an MPhys project report will tend to be scientific papers, and should include the authors (including initials), the journal name, the volume (often shown in bold), page number and year, e.g.

24. A.G. Grollick, J. Sprule and Z. Frisk, Phys. Rev. B **34** 2005 (1994).
25. O. Whacklow, T. Futtle and H. Crun, Solid State Commun. **291**, 567 (1968).

The references in other work will more commonly be text books, e.g.

B. Bleaney and B. I. Bleaney, "Electricity and Magnetism" (OUP 1987) p33.

Although it may be obvious to you where the derivation of (say) the etalon equation comes from, it may not be at all clear for the reader. Refer to the textbook from which you got the derivation or data.

You can use either the Harvard (alphabetical) or numeric style of referencing, but pick one style and use it consistently and correctly. More information is given in section 5 of AD15 — *Information sources in physics*[2].

Please note that all reports are written individually, and the only thing it should have in common with anyone you have worked with is the same data. You must always do your own work. Do not copy anyone else's. The University takes plagiarism very seriously, and it can lead to serious mark penalties or being required to leave your course. Most of your reports are run through plagiarism detection software as part of the assessment.

References are included in your page limit and should include everything you specifically reference in the report. Sometimes students choose to also include a Bibliography which includes other sources that you may have used or read when writing your report but which you are not specifically referencing. The Bibliography is not included in the page limit and you are not required to include it for any of the reports which you write during your degree.

7 Conclusion

To summarise the advice in this document:

- Write the report at the correct level
- Structure your report correctly using the template(s) we provide
- Make sure your abstract, figures and conclusions are clear
- Avoid the common mistakes of other students
- Remember to correctly reference any work which is not your own
- Writing reports is not something you get right first time!

Bibliography

[1] Various, *The Chicago Manual of Style*, 16th edition, University Of Chicago Press, 2010.

[2] W. Strunk Jr., E. B. White, *The Elements of Style*, 4th edition, Pearson Education, 2003.

[3] Various, *AIP Style Manual*, 4th edition, AIP, 1997.

[4] M. Young, *The Technical Writer's Handbook*, University Science Books, 2003.

[5] K. Friedman, Writing a Better Scientific Article, `http://rmp.aps.org/files/rmpguapa.pdf`

[6] Various, Duke Graduate School Scientific Writing Resource, `http://cgi.duke.edu/web/sciwriting/index.php`

[2] `www-teaching.physics.ox.ac.uk/practical_course/Admin/AD15.pdf`