3rd Year Laboratory – the 6-page report, 2024-25

The assessments in the 3rd year lab are designed to give you experience of reporting experimental work in the formats most commonly used by academics: a conference presentation, a short format (conference submission) paper and an academic journal article. The specific format of journal articles varies between disciplines, but their structure is designed to allow the reader to access the contents at increasing levels of detail if they deem it relevant. This is increasingly important since there are too many journal articles in a given research area for an individual to read. Therefore, before providing guidance on the 6 page report, I want to describe my approach to reading research publications. Below is an ordered list of the elements I read before reading the whole paper – if it becomes clear at any point the paper is either not relevant or important I stop reading (the reality is not quite as unequivocal, since we all read papers of more general interest and not just of direct relevance to our research field).

Authors/Research group – all academics are aware of the established and leading research groups in their respective fields. Therefore most academics will either set up alerts or regularly search for new publications by these groups. This is not a basis on which to disregard a paper (i.e. if you do not recognise the authors), but is about developing a picture of the research landscape.

Title, keywords (not included in this report) and abstract – these provide the most concise description of the contents of the paper, including the broad method used and the main quantitative results in the abstract.

Figures and captions – looking at a clear diagram/schematic of the experimental set-up and the data generated provides a very good understanding of the work contained in the paper.

Conclusion – this summarises the paper so should inform the reader if the contents are incremental, significant or ground-breaking.

Having scanned the sections above and deciding the publication is of sufficient interest I would read the whole paper. Hopefully this emphasises why the overall structure of a research paper and the specific contents of its individual elements are important, since they are professional documents designed to convey information in a particular format.

For this 6 page report we will follow a standard format, with the sections and their content outlined below.

The Title

This should describe the specific content of the report in a single sentence. It should not be the title on the lab script or a generic label (e.g. not “Experiment A1”).

The Abstract

The title and author list should be followed by an Abstract which provides a concise summary of the work presented. The aim of the abstract is two-fold. First it provides valuable “scene setting” for the bulk of the report, highlighting important points that the reader should take note of when they read the full text. Secondly, a very large number of papers are published in some subjects, and the abstract tells a potential reader if a paper will be of interest, without having to digest the whole work. It should mention important aims of the work, methods used, final results, and your main conclusions. Key numerical data should be included, i.e. your final results and values. However, it should not go into the general background of the work, specific details of the experimental method or data analysis. Around 100-250 words is usually sufficient.

The Introduction

The introduction is the section in which context is provided for the experimental work described in the paper. In research papers this often takes the form of a critical overview of preceding work and results in the research field, followed by a justification of why the work described in the publication is novel/superior/important in relation. Alternatively, it may provide a more historical view of a research field, emphasising the main developments/achievements leading to the current state of the art. The introduction concludes with a concise statement of the aims/objectives of the presented research. You should not go into deep technical detail in the introduction, but you should briefly state the main method/approach used (e.g. there are many ways to measure the speed of light, so stating what approach is used in the introduction is important, but not the technical details).

Theory Section

The structure of the report from now on depends on what experiment you have carried out, and the amount of theoretical background needed to understand your results. If some extra theory is required then this section generally follows the introduction. You should explain what equations and all symbols mean on first use and try to give a physical picture of what they describe. Simply writing some equations and expecting the reader to follow them without any explanatory text is not sufficient. Equations should be presented in a neatly type-set form with numerical identifiers (1), (2), etc, at the far right of the column to allow you to easily refer to them in the text. In longer pieces of work, it can sometimes be useful to combine the theory and linked methods and results into subsections in the form of a series of "mini-reports" followed by a global conclusion to draw everything together.

Experimental Method

Introduction and theory sections are followed by an experimental or method section. Here you can get quite technical, having already set the scene for the description of your apparatus and method in the introduction. It is essential that you make good use of well labelled diagrams and figures to explain what equipment you used and how it was set up. This is one of the best places to impress your demonstrator with your understanding of the experiment. When you say what you did, also say why. If you make a particular point of something in the set-up, discuss why you chose to do it in that way. If you encountered any problems or errors with the equipment this is also a good place to discuss them. Standard items of equipment such as oscilloscopes do not need to be described, and again you should avoid simply copying out sections of the lab script. General complains such as "my equipment was broken" do not make for good reading however.

Results, Errors and Discussion

Any numerical result you include in your report is meaningless without both units and an error. It is generally more useful and informative if you mix your presentation of results, error calculations and the discussion of results in one section. This is particularly true if your write up is built around several “mini-experiments”. Putting all the results together, followed by error calculations and then the discussion would require a reader to jump backwards and forwards through the report, trying to understand each part of the experiment. Remember the cardinal rule, make life easy for your reader, and put sections relating to a single experiment together. Results and errors should be given in the same units and numerical data should not be broken over two lines of text as this makes it harder to read and appreciate.

Conclusions

Finish the main text of your report with a conclusion. This should be a self-contained entity and you should briefly restate the aims of the experiment and method used in a few lines to remind the reader of the background to your results. The main job of the conclusion however is to draw all the elements of the report together, point out its successes and failures, say what you have achieved and learned

and how the experiment could be improved. It is important to include key numerical results and error values here and highlight how well these were a fit to theoretical predictions. Terms such as "good" should always be quantified, e.g. "The value determined for Planks Constant using this method was $6.6261 \pm 0.0001 \times 10^{-34}$ kgm^2s^{-1} which we considered to be a good result as it lies within $5x10^{-8}$ % of the accepted value [23]".

Bibliography

The aim of this section is three-fold. To act as a source of background reading and information for the interested reader, to provide proofs or sources for specific pieces of information vital to your case, and to acknowledge the efforts of others from whom you have drawn ideas and inspiration. In the bibliography you must give the full reference that uniquely identifies a single source, typically giving lead author, journal or publisher, journal volume, issue number, page numbers and publication year. For example:

[1] A. N. Other. “The Bumper Book of Integrals”. Cambridge Scientific Press (1995).

[2] D. Strickland and G. Mourou, Opt. Comm. **56**(3):219-221 (1985).

Appendices

For 3rd year laboratory reports you are required to include all the feedback you received for cycles 1 and 2 in an appendix.

More generally you might want to include additional detail on, for example, more detailed derivation of functional relationships/models, calibration data or other “bulky” items that would break up the flow of the report if you left them in the main text. In this case you can add an appendix at the end of the report including this detail and refer to it in the main text. It is important that the appendix begin with a short description of what it contains and why it is relevant before moving on to detailed technical content. However, the main text should stand alone without the appendix, so it is not an opportunity to circumvent the page limit.

A few additional points

• A well-structured report is vital if you want to present your results in an understandable and interesting way. Think about what you are going to include and draw up a rough outline before you start writing the report. Creating the key figures first helps in defining the overall structure and flow.

• Do not start a new section of the report with a figure, table, data plot etc. Begin with text to provide details/context for the following content.

• All figures should be accompanied by an appropriately detailed caption explaining the key elements of what is shown, and if possible, a "take away" message you want the reader to fully appreciate, e.g. "The departure from a linear trend at low temperature in this data set indicates a breakdown of the Shockley equation". Failing to appreciate this simple point is a major reason for lost marks. A caption that simply says "Fig 1. The Experiment" adds very little value.

• In general it is wasteful and redundant to both plot a graph and give a table of the same results, unless you want to make a particular point about some of the numerical values. When plotting a graph the points should be accompanied by error bars to give a clear visual representation of the error in your measurement. Plots should clearly show individual data points, not just a line connecting them, unless your data set is many hundreds or thousands of points and "odd trends" actually represent a real measurement, not the vagaries of an interpolation function.

• Avoid odd formatting glitches that create unwanted blocks of white space or over-run lines that push a small section of text onto the next page. This breaks up the flow and looks unprofessional. In particular watch out for figure captions being pushed onto a separate page/column from the figure itself. Reviewing and adjusting the global formatting of the report is usually the final job undertaken.