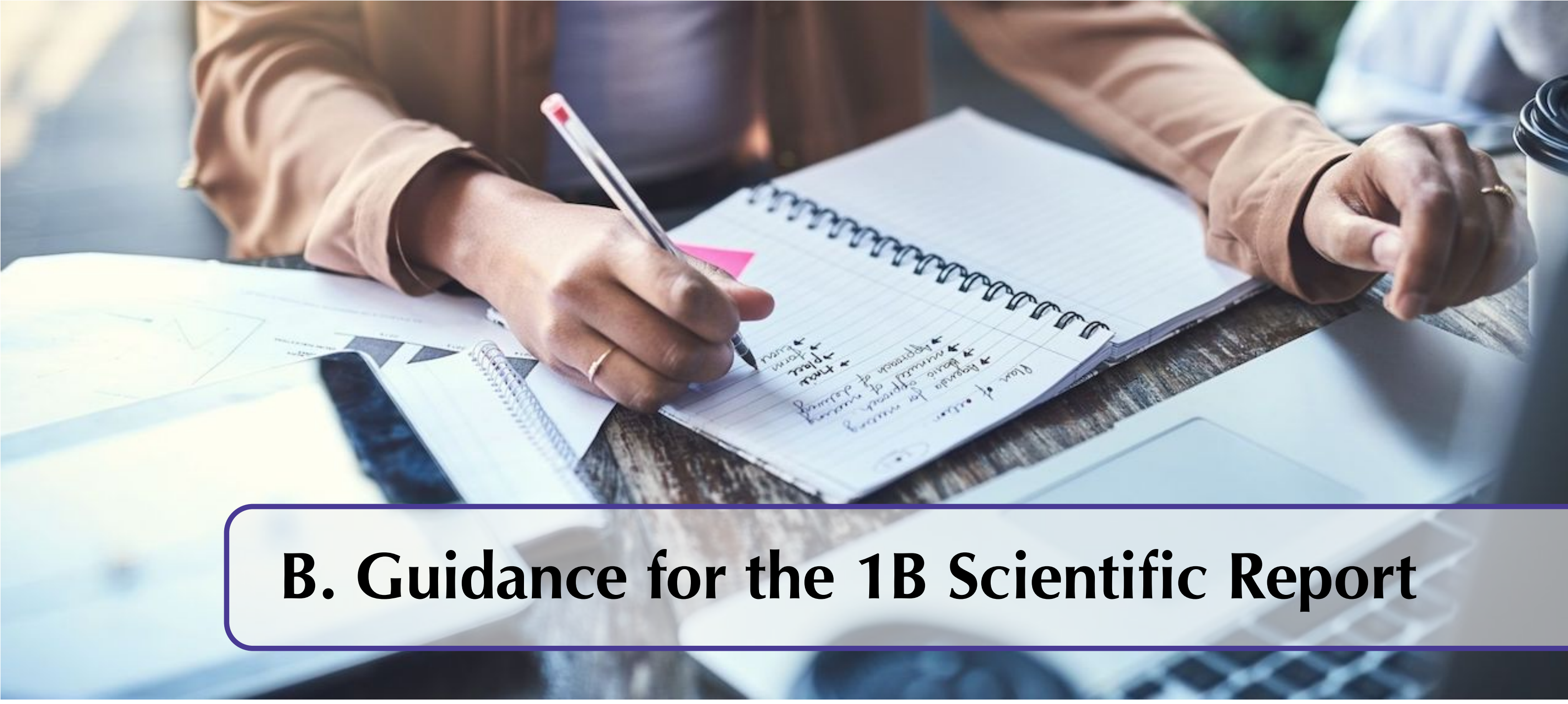

B. Guidance for the 1B Scientific Report

The Scientific Report in 1B has the same requirements as the full report you completed in 1A. However, assessors will normally hold the report in 1B to a higher standard compared to your 1A report.

The main criteria assessors will look at when marking your report are:

(a) presentation - 15 marks and

(b) understanding of the physics involved - 5 marks

The presentation mark is made up of three components:

(i) structure - this refers to how the different elements of the report are organised, what the section headings and sub-headings are, and the balance of information across the different sections.

(ii) clarity - clarity refers to how clearly and unambiguously you get your ideas across to the audience. Clarity is influenced by how you structure your writing, on the report scale as well as the paragraph scale, and the clarity and conciseness of your sentences themselves.

(iii) appropriate level of detail - the appropriate level of detail requires you to carefully think about the audience, i.e. another 1B Physics student who hasn't read the manual or seen the experiment. You will need to think about what might be interesting for them to know, as well as what would be important for them to know about in order to follow your report fully.

These three components can often be interdependent, i.e. a well-structured report is usually clearer, and inclusion of appropriate level of detail for different elements is essential for clarity.

There is a further criterion that is not captured in this list above, but is almost always seen in high quality reports. This can be broadly described as *'interesting-*

ness'. Most of us have many demands of our time, and we are more likely to engage with a piece of scientific writing (or another form of scientific communication such as a poster or a presentation) if the content is interesting for us and is brought to our attention in an engaging manner. Good scientific communication requires you to:

(i) understand your audience to determine which features of your work might be most interesting or relevant for them,

and

(ii) choose the appropriate forms of text, figures and tables that might convey your work to your audience in the most effective manner.

Note: There are many different approaches or strategies to achieve effective scientific communication. Sometimes the guidance or advice you receive from different sources, particularly in relation to matters of style, may appear to be conflicting. If you receive conflicting guidance or advice, the best approach is to use your judgement to determine what would work best for the particular situation you are in, prioritising the audience you are writing for.

To get samples of scientific writing that do an excellent job of science communication for a general scientific audience, take a look at some physics research papers from the journals *Nature* or *Science*. You will have to use the search function on the journal websites to find the papers in physics. Also note that these journals might contain many types of articles, such as news or perspectives (opinion pieces). When searching for articles to look at samples of scientific writing, make sure you limit your search to research articles only. To get samples of scientific writing aimed at a physics audience, you can take a look at journals such as *Physical Review Letters* or *Nature Physics*. Not all of the content of the research papers will be accessible to you at this stage. However, as a 1B student you can make a start. When looking at scientific research papers, pay particular attention to the abstract, figures and figure captions, conclusion, and the overall structure of the paper.

B.1 Before you start writing your report

Think carefully about which experiment you want to write about. It may be tempting write about the experiment that you think went the most smoothly. However, having problems to overcome often leads to a more interesting report, as you can write about difficulties and how to overcome them. Do make sure you have enough data to do the required analyses and write the report. Choose an experiment you particularly enjoyed is recommended, as it will help keep you interested throughout writing the report, and this usually shows up in your writing too.

Once you have chosen the experiment, think about which aspects of your work might be interesting for your intended audience (in this case, another Cambridge

1B physics student who hasn't seen the manual or the experiment). Make a list of things that you might want to highlight in terms of the physics, details of the experiment, your data and analysis, and the conclusions. Once you have this list, prepare an outline structure for your report that will help you convey the items on your list in an interesting manner. Think about the section headings and sub-headings you will use, and write down some key words corresponding to the content within them. Also prepare rough sketches of the diagrams and graphs you will use, and think about which headings or sub-headings they will fall under.

B.2 Preparing your first draft

If you haven't previously done so, complete the Writing scientifically tutorial on the STEMbridge NST moodle site. This tutorial covers several very important points for writing scientific reports, and although the examples are not based on physics, they do an excellent job of conveying the points effectively.

It is good practice to first prepare the figures and tables that you will use in your report. Although making good figures is time-consuming, it is a very important activity as it forces you to clarify and understand your own work better. Make sure to write detailed figure captions describing the salient features and take-away points for those figures and graphs. See points 4. and 6. in the Scientific Report Checklist for what you need to keep in mind when preparing figures and figure captions. The caption for each figure or table should be preceded by a label such as Figure 1, Table 1 etc. These labels should be used to refer to the figure or table within the main text.

Once your figures and tables are ready, you can start working on the main body of your text. When writing your text, remember to apply what you have learnt about clear, accurate, concise and well-reasoned writing from the research skills session, and from other sources available to you.

Write out all sections of your report in accordance with the outline structure you prepared. However, leave the abstract to the end. When structuring your report and writing individual sections, make sure you explain the physics first and then the technical details. For avoidance of ambiguity, define even standard symbols before you use them (e for elementary charge or $\mathbf{c}$ for velocity of light.

Think about the target number of words for each section, bearing in mind what might be most interesting for your readers. For example, the discussion of your results and your conclusion will be far more interesting to read about than the minutae of technical details that are not directly relevant to your conclusions. In general, you will have make a trade-off between including all the relevant details for what you choose to talk about, and ensuring that the main points you want to highlight don't get drowned in less relevant information. When making this trade-off, always keep your audience in mind and think about: (i) what they might already know, (ii) what they might find interesting to know, and (iii) what they would definitely need to know in order to follow your work fully.

Do NOT rewrite the lab manual when describing the technical details – you need to be selective about which aspects of the technical details are most relevant or interesting for the reader.

Once you have written the entire report, you can proceed to write the abstract. Remember, the abstract is NOT the same as an introduction. It is a short summary of the main points of the report covering what was done, how it was done and what the main results (including numbers) and conclusions are.

B.3 After writing your first draft

1. Look through the **Scientific Report Checklist** at the end of this manual and apply the suggestions to improve your report.
2. Make sure you have set aside enough time for **at least one other person to read your report** and provide feedback.
3. **Proofread** the whole report before submission.

B.4 Typesetting

At some point during the writing process, you will need to decide on what software you use for typesetting. Microsoft Word may work for you, but Latex will usually provide a superior result, and also works more reliably in most instances. Overleaf is an excellent way to get started with Latex. To get started with overleaf, take a look at the beginners guide available on their website, as well as some of the document templates they provide.

B.5 Common issues found in previous 1B reports

The following points are frequently noted by assessors of 1B reports as areas of improvement. *Make sure you take these comments into account when preparing your first draft.*

1. **Appropriate level of detail and analysis.** Reports were often missing:
   - Error bars on graphs
   - Crucial details about the method and numerical results within abstracts
   - Quantitative comparison of data to theoretical predictions
   - Discussion of uncertainties and error sources
   - Schematics for experimental setups
2. **Clarity and readability.** Common issues include:
   - Implicit reliance on the lab manual - making the report inaccessible to someone unfamiliar with the lab.

- Imprecise language, leading to potential confusion.
- Equations and terminology not always clearly introduced or explained.
- Transitions between theoretical concepts and experimental details were sometimes abrupt.

3. **Figures.**

- Try to integrate figures into the text better (think about figure placement – e.g. when they are first introduced, or where they are most relevant)
- Missing labels or descriptions on figures.
- Figures not always introduced before appearing.

B.6 Scientific Report Checklist

1. Is the **title** interesting enough? It should be a bit like the title of a paper, i.e. report on what has been discovered, or what is of importance in the work. Titles can be quite long, even 20 words can be OK. Titles in the form of statements can be very effective. Try to make your title something *unique*.
2. Is the **abstract** in the form of a paper? A few sentences on what is the question / open problem. A few sentences on what has been done and how. A few sentences on the main results, which can contain some detailed values if relevant. A concluding sentence to say where this all leaves us.
3. Are the **section headings** well-structured? (a) they should be relevant to what is actually in the section, but also (b) they can be made up of *several* words. So best to make them unique, and interesting. Like for the title, often a heading in statement form can be effective, and might be better than just a description. The collection of headings and subheadings is like the skeleton of the work, the text hangs on this.
4. **Headings, structure and layout.** Are the pages, sections, figures, tables, references, all properly numbered? They need to be in order. Figures (all of them) must all be referenced from the text, in the right order. It is often most tidy to put all the figures at the top of pages, and all tables at the bottom of pages.
5. Making a good **figure** is hard. But essential in science and tech communication of your results. Learn to use Matplotlib effectively, develop sets of formatting that work well. Fonts should be at least as big as the caption font when you include the figure in the typeset. Data markers should be solid to convey confidence, but not too big to hide each other or their errors. Try to converge multiple datasets to the same axes, and to have theory lines fitted or compared to the data, as this allows good discussion and highlight of discovery. It might be relevant to think of clever ways to plot data:

scales, inverse quantities, dimensional or dimensionless quantities, etc. Labels should be below the x-axes and to the left of the y-axes, and should contain the quantity name and the units. Legends are rare in papers, usually all the info is in the caption. *No*: grid lines or titles. Yes, sometimes, to arrows, text and other annotations of particular features on the data. Try to make your data and figures tell the story.

6. **Figure captions** can be very useful to the reader. They should contain relevant information to interpret the figure, even if this is also in the text. If the figure has any markup (fit lines, various markers/symbols) or if the figure has multiple panels, all this is to be described in the caption. It is also a good communication strategy to tell the reader what *you* see in the data, i.e. why/what it is interesting.

7. Do you have some good **references** (good means ideally primary literature, i.e., other papers) to support your statements, and to compare your results with?

8. **Conventions**: units are not typeset in italic; functions and subscripts representing words are not typeset in italic; variables are typeset in italic.

9. **Conventions:** Abstracts and conclusions don't usually appear with bullet points, and do not usually have tables or graphics. Paragraphs are almost never made up of single sentences.

10. **Tidy up.** In science, you prepare your work all the way to a typeset form. That means you are responsible for all aspects of how things appear (as well as the content, of course). Headings that go out of margins, or overlap, or headings at the bottom of a page, or large empty spaces, ... all these are to be fixed by you.