MONASH University
Engineering

Guidelines for Long Form Report for Laboratory Experiments

These guidelines closely follow the guidelines written by Dr Paul Webley, Department of Chemical Engineering, Monash University, 2005. The guidelines here provide detailed general advice on writing a long laboratory report. You should always check the particular requirements for the laboratory reports in your units as these requirements vary considerably.

In Engineering, you will take a number of units which involve laboratory work and after completing the work, you will be required to write clear concise and logical reports of the experiments. Guidelines on the conventional format and style of in engineering laboratory report are given in this resource. Note that the ability to write a clear and succinct report of your work is fundamental to your success as a practising engineer in industry.

1. Length and general features

Usually your report should be typed in font size of 11 or 12 points and line spacing 1½ or 2 (double-spaced). Most long form laboratory reports will be between 15 and 20 pages including graphs and figures.

2. Assessment

A typical report marking sheet is included at the end of the guidelines. Marks are usually awarded for the following aspects of your report: Summary, Introduction, Aim, Experimental Apparatus and Procedure, Results and Analysis, Discussion and Conclusion, overall written style (including grammar and spelling) and presentation. Always check the particular assessment criteria for the laboratory reports in your unit so that you know exactly what the marker is looking for in a good report.

3. Cheating

The report must be your own work. The university defines cheating as “Any means used to obtain an unfair advantage in work submitted for assessment.” (See detailed explanations including penalties in the Student Resources Guide, Cheating/Plagiarism and Discipline). Any sentence substantially copied from another source, or any copied diagrams, must be acknowledged by giving a reference. Students may work together to check the accuracy of their results and deepen their understanding. However, you should write in your own words independently of other students and thoroughly understand what you write. Assisting another student to cheat by loaning your work is also an offence.

4. Format, figures and tables

Headings

You should use headings and subheadings which are clear and meaningful. Do not write "Part D" and hope that the reader knows what Part D is from the laboratory manual. Headings and subheadings should be numbered. Do not use dot points (●) for sub-headings or lists. The following example illustrates a series of headings:

1. Experimental Apparatus
    1.1. Steam Boiler
        1.1.1. Steam Measurement Device
        1.1.2. Heater configuration
    1.2. Turbo-generator

Figures and tables

Figures and tables should be numbered within each section. Figures can be sketches, images, photos, schematics and graphs. Regardless of type, they are all called Figures in the report. The first figure referenced in section 1 should be called Figure 1.1. Successive figures in section 1 should be Figure 1.2, Figure 1.3, etc. Figures are numbered in the order in which they appear in the text. Follow the same procedure for Tables. Figures and tables can be embedded directly into the report or they can occupy a separate page directly adjacent to the point in the text at which they were introduced. Do not put all your figures together at the end of the report: put them close to your commentary on them so that the reader can easily find them. All Tables and Figures must have meaningful captions not just “Graph of Y vs X”. All equations must be numbered.

Example of equation:

$$y = mx + c \qquad \text{(Eq. 2)}$$

Examples of figure and table captions:

Figure 2.1 Circuit used to measure resistance

Figure 4.5 Effect of temperature on the resistance of a banana

Table 3.1 Data for wave speed as a function of wire diameter

Graphs

Pay particular attention to graphs. Each graph should have a caption/title which must be descriptive. For example, if you have a graph showing the effect of temperature on efficiency, then do not use the caption “Temperature vs Efficiency”. Rather, use “The Effect of Source Reservoir Temperature on the Thermal Efficiency of the Stirling Engine”. A reader should be able to detach the graph from the report and still know/understand the content.

Use ***points*** for data and ***lines*** for model predictions. Do not feel you have to curve fit every set of data. There is no point putting a linear curve fit through data unless you have a physical reason for believing that the response should be linear. Do not force the lines to go through every data point – this is physically unreasonable and not consistent with experimental error in your data.

5. Content and Structure

The sections below describe the main content in the report in the order in which they should appear.

Title, Author (and student ID), the time and place the experiment was done and the date the report was submitted.

The title should contain key words which clearly describe the main content of the experiment. Do not write a title that is too long or so short that the meaning is unclear. This section can have its own page.

Summary

Always provide a summary of your work/report – this is often the only part that is read. The summary should do exactly that: summarize your work. Start with 1-2 lines introducing the subject area, then 1-2 lines on the goals and scope of the work, then 1-2 paragraphs on how/what you did, then 1-2 paragraphs on your results and finally your main conclusions. Try not to exceed 1 page in total. You may want to write your summary after you have completed the rest of the report. When you have written your summary, ask yourself "If I remove this summary from the rest of the report and give it to someone else to read, will they know what I did, how I did it, what my overall findings were and what I concluded?"

Table of Contents

The table of contents comes after the summary but before the remainder of the report. You can use Word to generate this for you (Insert….Field….TOC). This assumes you have used appropriate heading styles for your headings. The table of contents requires that you have page numbers in your report.

Introduction

This section introduces theory, background and motivation in the context of the experiment. Introduce the field ***specific*** to your experiment – you can assume that the reader has an engineering degree and is familiar with basic engineering principles and topics. For example, when introducing the steam turbine laboratory, you do not have to cover the history of the steam engine nor describe the first or second laws of thermodynamics! Briefly outline the essential theory and key

equations used in the relevant parts of the experiment. Detailed derivations of equations are not required, but you need to refer to an appropriate source for the theory as outlined below in the section on Referencing. Remember, the goal of your introduction is to provide the reader with the context for your experiment and make them ready to accept and understand the aims of the experiment introduced in the next section. Finish your introduction with a brief mention of what your work is intended to do. (For example, *The focus of this experiment is the relationship between X and Y …….)*

The introduction is where you cite any literature that you believe is relevant to the question(s) that you are addressing in your experiment – do not just cite references that are only remotely connected to your work. Do NOT plagiarise – if necessary refer to textbooks if a large body of work is relevant. The introduction should be no more than 2-3 pages in a long form report.

Aim

You state the aim of the experiment in this section. Aims must be written in complete sentences or in point form.

Examples

Aim: This experiment aimed to establish whether the addition of gibberellic acid had a similar effect on the growth of tall and dwarf pea plants.

OR

Aim: To establish whether the addition of gibberellic acid had a similar effect on the growth of tall and dwarf pea plants.

You may have several aims in your experiment – list them all if this is the case.
Distinguish between aims and tasks. For example, “measuring the flow rate of the steam” is not an aim – it’s a task. The aim might be “To determine the effect of steam flow rate on pressure”.

Experimental Work

Often, you may want to break this down into
3.1 Experimental Apparatus
3.2 Experimental Procedure (or Method)
In the Apparatus section, you draw and describe the apparatus used in the experiment. You should include a good description of unusual custom-made items, but standard instruments do not need any detailed description beyond a statement of the instrument and its model.

In the Procedure section, you outline <u>how</u> you did the experiment.

Language style in procedure section

Do <u>not</u> copy out the procedure of the experiment from the lab notes. Change this procedure into a report of what you did, using the past tense passive voice for the verbs (for example: The temperature ***was measured***.).

Example:
In the laboratory handout, the procedure might be written as "Procedure to determine the density of a steel sphere using a balance":

1. First find the zero reading of the balance.
2. Then put the sphere in the left pan and put weights into the right pan to bring the pointer to zero and obtain the apparent mass.

This procedure must be changed into a report of what you did as follows.

> First the zero reading of the balance was found. Then the sphere was put in the left pan and weights were added to the right pan to bring the pointer to zero. In this way the apparent mass was found.

Remember, others may want to attempt to duplicate your data or understand why their data is different to yours. An accurate and clear description of the procedure is therefore very important. You should also mention here any particular safety issues or difficulties that may arise during the experiments and how you overcame them. This is also the section where you highlight sources of experimental error likely to affect your results and discussion in the next section.

Results and Discussion

In the Discussion of Results, you interpret your results and explain the significance of what you found.
To interpret your results you may have to

- compare your results with accepted values
- compare your experimental results with each other
- explain errors
- comment on trends shown by a graph
- comment on the suitability of the method used in the experiment.

The major experimental results of your investigation are presented here and discussed. In essence, this section seeks to solve the problem that you examined in your experiment.

This is the report of the main part of your investigation and it can be up to 5-10 pages long. If possible, use graphs to present data. Tables can also be used but become very hard to read when more than 10 data points are presented. You may wish to put large tables of raw data in an appendix. Make sure graphs and tables have meaningful captions. It may be convenient to present all the results first and then discuss them all or to present and discuss them one at a time – each experiment is different and the best method is experiment specific. See two options below.

Regardless of the method you choose, you should NOT present results without discussing them. Do not show data/graphs if you are not going to discuss them. Data such as calibration curves do not need to be included in the report. However, you may choose to include them in an appendix.

When discussing results you need to point out the trends and explain why they are as they are. Ask yourself

Do the results agree with your model/theory? Why not?
What experimental limitations were there that might have affected the accuracy of your data?
Were your results expected?

The discussion is primarily about what the results mean. For example, when you obtain a graph of a desired form (e.g. a straight line) be sure to state that this indicates a certain relationship between the variables – do not simply find a value of the slope and forget to say, for instance, that the data supports the theoretical linear relationship between the pressure and liquid flow rate. You should attempt to include uncertainties in your data so that statements such as "the data were in good agreement with literature values" can be assessed. Claiming that the difference between your result and the expected value is very small and hence your result is accurate is not valid: the uncertainty in your result is the indication of accuracy.

Often there are questions in the laboratory manual which can provide material for discussion: **these questions must NOT be answered in the form of separate answers to Question 1, 2 etc**. These questions are provided in the manual to help you understand when you do the experiment; the understanding gained should be integrated into your discussion.

For multiple part experiments you have to decide how to arrange the content. If the method, equipment used or main aim is similar for all parts then Option 1 below is more suitable. If the different parts use different methods or investigate different features or utilise different theory, then Option 2 may be better.

Option 1		**Option 2**	
Introduction	Part A theory, equipment Part B theory, equipment	Part A	Introduction (theory, equipment) Results Discussion
Results	Part A results Part B results	Part B	Introduction (theory, equipment) Results
Discussion	Part A Part B		Discussion
Conclusion			Conclusion

The advantage in Option 2 is that the results and discussion immediately follow the introduction. Whichever structure is used, use heading and sub-headings to ensure that the reader can easily follow what results and discussion relate to which part.

Language points for the discussion:
Use the following formal and precise expressions in your reports.

If your measurements correspond well with the published values, state that:
The measurements are consistent with the standard value.
The measured values agree well with the published value.

If your measurements do not correspond well with the published values, state that:
The measurements are significantly different from the standard value.
The measured values do not agree well with the published value.

To explain the source of errors, use the following expressions:
The error may be the result of incorrect calibrations.
The discrepancy may be due to human error.

Conclusion

Present a short (< 250 words) conclusion of your work. Say what you did and what your findings were. Summarize limitations of your work and outline future work that should be done. This section is NOT a repetition of your discussion – it is your **conclusion**. State whether the aim of the experiment has been achieved or not, summarise the key features of the method used, and summarise the most important results.

The conclusion can be seen as a "response" to the direction of the experiment outlined in the introduction. It will normally include key numerical data where appropriate, along with experimental uncertainties, and comparisons with expected values. The significance of the results may be included.

Acknowledgments

Acknowledge any assistance you may have received in doing the investigation.

Nomenclature

The nomenclature should be clearly indicated here. All symbols used in the text should be clearly defined together with their units. If necessary, define all subscripts and superscripts.

References and citing

A reference is a detailed description of any document from which you have taken information. It can be a complete book or just a chapter from it, or an article from a

journal or newspaper. “Citing” a reference is the act of recording it in the text of the report. You cite the reference by putting a brief entry for each source next to the item of information in the text of your work using a particular system of referencing.

Do not provide a list of references of potentially useful sources which you have not used, and do not provide references to material which should be commonly known by a student at your level. For guidelines on using the author-date (or Harvard) referencing system, go to the online resources for undergraduate Engineering students or to the online tutorials on Citing and Referencing on the Monash University Library website.

Appendices

Appendices are used for including information and data which is useful for more detailed analysis but which would detract from the flow of the main report if included in the body. Such data could be calibration charts, intermediate data from analysis etc. It may also be useful to include a sample calculation here to illustrate your analysis.

Report Checklist

Have you read your report from cover to cover?

Have you checked for spelling and grammar?

Do you have all of the sections as required?

Is the formatting correct?

Do all of your Figures and Tables have good captions?

Do you have a table of contents?

Do you have page numbers?

Do you have a title page?

Do you have a report coversheet?

Is your referencing correct according to the Harvard Style?

Assessment - Report Marking Scheme

A typical marking scheme is shown below showing the relative importance of each aspect of the report. However, always check the assessment guidelines and marking scheme for the lab reports in the particular unit you are studying.

Summary	5
Introduction	10
Aim	5
Experimental Work	15
Results and Discussion	20
Conclusions	5
References and Nomenclature	5
Quality of Figures	5
Quality of Tables	5
Overall Presentation (incl. title page)	10
Style, Accuracy of Writing, spelling	15
TOTAL	**100**