Formal Reports

From time to time in laboratory modules, you will be expected to produce a formal report on selected experiments carried out in the laboratory. This report is the method by which you communicate your experimental work and its results and interpretation to the outside world. Its importance cannot therefore be overestimated. The **aim** of the report is to convey to the reader as clearly, concisely and convincingly as possible the description of the work of the experimenter. The most important single point in report writing is **clarity.** It is possible to distinguish two types of report. Usually, in physics, you will be writing a scientific report on an experiment which illustrates some physical principal. However, it sometimes happens that you might be involved in a project which designs and constructs some form of instrument. In this case, you will write a design report. Both types of report have common elements. Common elements will be in black script. Specialist elements will be in green for scientific reports and blue for design reports.

General Points

The aim of writing a report is to inform the reader in as clear and concise fashion as possible. You should remember that you are writing a report at University level and simply saying what you did is insufficient. You need to explain what you did, why you did it and what your results mean.

- Reports should be written in good English or Welsh throughout, using complete sentences, paragraphs, etc, and spelling should be checked.
- Reports should be word-processed with a standard font such as Times New Roman with a minimum font size of 12
- Line spacing should be a minimum of 1.5 lines
- Use the passive voice in your report. (e.g. “the measurements were taken ...” rather than “We took the measurements …”. Never use personal pronouns in scientific reports.
- Actions that took place in the past are described in the past tense; results are presumed to reside in the present and so are described in the present tense. (“The voltage across the resistor was measured from 100 Hz to 10 kHz” because that action was performed at a specific past time. BUT, if you determined the frequency response of the circuit you made measurements on, to describe this to the reader, you would use the present tense “The presence of a sharp peak in the voltage at 1 kHz confirms the resonant behaviour of the circuit”)
- Never start a sentence with a numeral (e.g. “3” is a numeral “Three” is not)
- “Data” is a plural word.

Some of the general points to be covered in the report are provided below.

1. Title and author(s).

The title tells the reader what the work is. It should be precise and clear. The authors’ names and affiliation should be included.

2. Abstract.
An abstract is a brief and concise summary of what the work is about. It should state the purpose of the experiment, mention any important methods used, final results and your conclusions. It should not go into any detail and usually around 50 to 100 words are sufficient. The abstract should neither contain literature citations nor references to figures or diagrams.

The abstract must stand on its own so do not make any statements that require further explanation. Write the abstract so that it makes sense to a reader who has not read the rest of the report.

An example abstract:
"*The refractive index of sodium silicate glass was measured at 632.8 nm. A new method, based on a Brewster angle technique, and using a helium-neon laser as light source, was employed. A refractive index value of n = 1.53 +/- 0.02 was obtained, comparing well with literature values, and confirming the effectiveness of the new technique*."

The title and abstract should be on a single page, separate from the rest of the report.

3. Introduction.
This answers the following questions for the reader.
a) What exactly the work is
b) Why it was done
c) What must be known in order to understand the work (background material and its relevance to the present work). This includes the introduction of the underlying physics, any mathematical relationships and any definitions relevant to the study.

4. Experimental Procedure/Design Procedure
Here, enough detail should be given so that, in theory, someone else could repeat the work. The reader should be told the method of measurement of every factor contributing to the final result, but this description should not degenerate into a list of experimental trivia. Insert only enough detail so that the reader can judge the validity of the procedures. In particular, you should emphasise any details of care or precaution, which proved necessary to perform the experiment.

Here, you present the design itself, the theory behind the design, problems encountered in producing the design, and how those problems were, or could be, overcome.

A line drawing of the experimental apparatus or the circuit diagram of an electrical experiment should be made. Diagrams exist to aid the reader and should be as simple as possible. They should be neat and clearly labelled.

Identify all measuring apparatus. Omit standard items such as stands, clamps, etc. You should, where possible list
a) The name of the apparatus and manufacturer, model number (and serial number, if available)
b) The range of values covered, scale division, or instrument limit of error as specified by the manufacturer.

5. Results.
The results state only what you have measured in the course of experimental work or the results of any test on the design. **Remember that any numerical result put in a report is meaningless without both units and an error.**

Results may be presented in the form of tables or in the form of graphs. You should not produce both for the same data. Graphs show trends in data. If there is no trend or if a high degree of accuracy is required, then a table should be used.

Each table needs a title at the top. The units of the quantities being measured will appear at the top of the data column. **Every measured value should have its uncertainty indicated.** If the entries in a whole column of readings have the same uncertainty, this can be quoted once at the top of the column.

Graphs should have their axes clearly labelled and **error bars shown**.

Having presented tables and graphs, you must now make some statement about your results. This statement should state only what you have found and should not include any discussion of the results.

5a. Data Analysis
If your results require a lengthy analysis, it is often better to split the results section into two sections, one called Results and the next called Data Analysis. The Results section is used to present your measurement and to perform simple analysis (e.g., averaging multiple measurements of a quantity). The Data Analysis section is used to outline and perform more complex analysis (e.g., regression analysis or hypothesis testing). The Data Analysis section will usually contain quantities that you have derived from your measurements.

For example, consider an experiment to measure gravity where you drop a ball from different heights and time how long it takes to hit the ground. In the results section you would include your observed results (the heights and timings) and any measurements of quantities (such as the mass of the ball). Simple calculations may be carried out here (e.g., if you repeat the experiment several times from the same height, you may calculate the average time it takes to drop from that height - including errors). In order to calculate the value of gravity, you perform a regression analysis (calculating errors), and use the results from this to calculate the value for gravity. This regression analysis and a statement about its result should appear in a data analysis section.

All of the rules about stating numerical results with errors and presenting graphs and tables that were discussed above, also apply to the Data Analysis section.

Note, not all reports will require a Data Analysis section.

6. Discussion

The discussion section assesses your results. It tells the reader what the results mean. The discussion should attempt to address some or all of the following questions.

a) What is the interpretation of the results, in the light of any hypothesis and the published literature?

b) What are the significant sources of error in the results?

c) How reliable are the results

d) Do the results support any hypothesis?

e) What changes in experimental procedure would give better results, or what additional experiments would help support or refute the hypothesis.

The discussion section summarises the design and testing work completed and assesses how well the design meets the objectives presented in the introduction. If the design does not meet the objectives, you should analyse the reasons the design did not work and what could be modified to make the design a success. You should also provide a perspective for how the design will be used in the future.

7. Conclusions

This section finishes the main text of the report. It should be a self-contained entity. Briefly restate the aims of the experiment and the methods used in a few lines to remind the reader of the background to your experimental results. The main purpose of the conclusion section is, however, to draw all the elements of the report together, indicate its successes or failures, point out what you have achieved and learned, and how the experiment could be improved.

8. Acknowledgements

Limit these to those who helped directly in the work or during discussions on the subject of the work.

9. Appendices.

The best use of appendices is for supplementary material that is necessary for completeness but which would detract from the orderly and logical presentation of the work if inserted into the body of the paper (e.g. derivation of an equation). They may also be used for supplementary material that is valuable to the specialist but of little interest to the general reader. Data sheets may also be placed in an appendix.