A Guide to Writing Formal Lab Reports for Physics 211

1 Experiments which require formal reports

Of the experiments you will conduct in the Physics 211 laboratory, the following three will require formal lab reports:

1. **Experiment A**: Coulomb's Law.
2. **Experiment F**: Current Balance.
3. **Experiment G**: The Charge/Mass Ratio of the Electron.

2 Sections of the formal reports

Each of the formal lab reports will consist of the following sections:

1. **Abstract**
2. **Theory**
3. **Apparatus and Procedure**
4. **Results**
5. **Discussion**
6. **Conclusions**

3 General tips on the overall report

- The report should be written in proper English, as opposed to, e.g. point form.
- The text should be clear and coherent.
- The report should not contain incorrect or irrelevant statements.
- The report should not have any spelling or grammatical mistakes. Marks will be deducted for these sorts of errors.
- The report should be typed using a word processor. Hand-written reports will be accepted as long as they are neatly written. Marks will be deducted for sloppiness in such cases.
- The order of the report should be as described in the previous section. For example, graphs and tables of data should not be presented as appendices to the report, but should be in the proper place as described in the section below.
- **A note on language style in lab reports**: When describing a step that you carried out in the experiment in your report, you should use the "passive voice" in the past tense. An example of this style is the following:

  > "Electric charge was placed on the conducting sphere by first touching the charging sphere to the van der Graaf generator, and then to the conducting sphere."

  The key words that put this sentence in the passive voice past tense are "was placed". By contrast, the following sentence is inappropriate for a lab report (though they might appear in the experimental instructions of the lab notes given to you in advance):

  > "Place electric charge on the conducting sphere by first touching the charging sphere to the van der Graaf generator, and then to the conducting sphere."

  This is neither in the past tense, nor in the passive voice.

4 Tips on specific sections of the report

4.1 Abstract

- The abstract is an extremely important part of any scientific article or communication. It is essential that you learn to write a proper abstract. This will constitute a significant fraction of the total mark of your lab report.
- The purpose of the abstract is to provide the reader with a very brief description of the purpose of the experiment, the basic method used, the key results, and a comment on the results in the context of the purpose of the experiment.
- The abstract should be short, i.e. no more than about 5–6 sentences.
- The abstract is not just a statement of the purpose of the experiment.
- The abstract should not go into excessive detail about the experimental procedure, which will be described later in the report. The description about the procedure in the abstract will generally be no more than 1–2 sentences.
- The abstract can be the most difficult section of the lab report to write. You must balance tendency to omit key details with that of putting too much unnecessary detail.

4.2 Theory

- The theory section should contain the essential background theory required to understand the purpose and procedure of the experiment.
- Generally, this will not need to be a long section, as most of the theoretical background is supplied with the experiment description in the lab notes. Nevertheless, you should always at least supply a condensed description of what appears in the lab notes.
- Be sure to explain the meaning of the key equations presented. This always includes the meaning of each symbol in the equation, as well as the physical context of the equation.
- Each equation should be labeled by sequential numbering. This makes it easier to refer to any specific equation in the text.
- Any derivation of an equation that is required for the report should be presented in this section.

4.3 Apparatus and Procedure

- You should provide a list of the components of the apparatus, as well as a brief description (in 1–2 sentences) of each of the more significant components.
- The description of the procedure does not have to be as detailed as that in the lab notes.
- In some cases, you might have had to figure out for yourself how to conduct a part of an experiment, or you might have chosen to do something different or in addition to what was described in the instructions. In these cases, be sure to include a description of these parts of the procedure in this section.
- As usual, it is important to balance the need to include essential details with that of avoiding a description with excessive or irrelevant detail.

4.4 Results

- The "Results" section of the report will contain all or most of the following components:

    1. Tables of data and associated uncertainties, including both raw data and derived quantities.
    2. Graphs of data, showing the variation of one measured (or derived) quantity with respect to variation of another.
    3. Calculations of derived quantities. In the case where there is a lot of repetition involved, you may keep it short by just showing one sample calculation.
    4. A statement for how uncertainties in measured quantities were chosen or determined.
    5. Sample calculations for uncertainties in derived quantities. Be sure to use the uncertainty propagation rules presented in the tutorial earlier in this course.

- This section should also contain short paragraphs (i.e. explanatory notes) of text introducing or describing the various tables, graphs and calculations presented.
- The explanatory text should explain the meaning of symbols used for new quantities (e.g. quantities derived from raw data) introduced in this section.

- In the case of tables of numerical data, note the following:

    1. Every table should have a number and title; for example:
       "Table 1: Results for the Variation of the Electric Force with Respect to Distance".
    2. Labels for quantities in tables should always have the units employed.
    3. The uncertainties in all of the raw data and derived quantities should be included in the table.
    4. **Careful about significant figures**: uncertainties always have 1 significant figure, and the number of significant figures in any reported quantity should always be consistent with its uncertainty.

- In the case of graphs, note the following:

    1. The graphs should be NEAT!
    2. The graphs can be hand-plotted on graph paper, or generated using computer software such as spreadsheets.
    3. In the case of hand-drawn graphs, the horizontal and vertical ranges of the graph axes should not be such that the graph completely fills the entire page of graph paper.
    4. Instead, you should construct graphs where the vertical and horizontal ranges are (if possible) between 1/2 and 3/4 of ranges on the graph paper.
    5. The graph should be centred on the graph paper. This means, for example, that the origin will not be at the extreme bottom left-hand corner of the sheet of graph paper.
    6. Every graph should be labeled with a number and a descriptive title; for example:
       "Figure 2: Restoring Angle vs. Distance Between the Charged Spheres".
    7. Axes of graphs should be labeled.
    8. The units of the quantities plotted in the graph should be included in the axis labels.
    9. Estimated or calculated uncertainties should be included as error bars in the figures. Error bars may be vertical and/or horizontal bars attached to the plotted points.
    10. In the case where you fit the experimental data, for example, to a straight line, overlay the straight line on the experimental data in the graph.
    11. Do not include any other text or information in the graph. Any explanations or calculations should be placed in the regular text of the report.

4.5 Discussion

- This is the singly most important section of the lab report.
- In this section, you provide an interpretation of the meaning and significance of your experimental results.
- It should include an explanation for how the experiment did or did not validate a particular hypothesis that you sought to test in the experiment (e.g. the electric force between charges varies proportionally to the magnitude of each of the charges).
- If the experiment did not validate the hypothesis (which is predicted from a physical law), be sure to provide an explanation in as much detail as possible for why the expected result was not achieved. (This is especially relevant for the Coulomb's Law experiment, which is an especially difficult experiment for which to achieve quantitatively precise results.)
- In all experiments, you should also include a description for the various sources of error, and suggestions for how the error could be minimized.
- However, do NOT include trivial statements such as the following:

  "One possible source of error was human error. To minimize the effects of this problem, the experiment should be performed more carefully".
- Where possible (and where this does not overlap with the suggestions in the point above), you should suggest general improvements to the experimental method.
- **A final comment**: This section is where it will be most evident whether you really understood the experiment, and the procedure you followed. Be careful to think through what you write here.

4.6 Conclusions

- This section should only be several sentences long.
- Its purpose is to summarize the key findings of the experiment.
- In many ways, it will overlap with the abstract, but should be somewhat more detailed.

5 Formal Lab Report Correction Key

The lab report correction key that will be used in the grading of the formal lab reports is presented on the next page. It might be useful to use it as a checklist when writing your report.