Preparing Laboratory Reports

I. Report Format

You must type your report. Laboratory reports for this course will be very streamlined, since we want you to focus on understanding the physical ideas rather than on crafting extensive scientific reports. This does not mean that the formatting or styling of your report does not matter - **it absolutely does** - it just means that we are taking a simplified approach to what some other courses may ask of you. Your work in your lab report is expected to be clear and concise but still be complete. This means you should work things out on scratch paper or on a chalkboard before writing up your lab report. The report you hand in should consist of the following parts:

1. **Identifying information:**

   - Your name (underlined)

   - The names of your lab partner(s)

   - Your lab time (Period 2, 3, 5, or 6)

2. **Abstract:** Include a *brief* description of the experiment(s) you performed (as in what you actually *did* in the lab) and something about its larger "real-world" or historical context. This section should be no more than two paragraphs in length.

3. **Answers to the questions** including any necessary data analysis, calculations, and plots. Clearly label/title all material such as plots and tables and reference them by this label in your answers/explanations.

4. **Raw data** as an appendix, attached to the end. You also should title you appendices (e.g. Appendix A) so they can be referenced in your answers if necessary.

No introduction (beyond what is requested in step 2), methods, procedure, or conclusions sections are required in your lab reports this term.

II. Answers to Questions

Most questions will require answers that include a numerical answer as well as an explanation or some sort of response. Provide this explanation as a concise, clearly worded statement. Just because this is a science course does not mean you should forget how to write well. You should spellcheck, make sure you use good grammar, write in complete sentences, etc.

However, don't forget that the mathematics is also a key part to your method, so whenever calculations are required, show them in full detail. You must type your report, however where calculations are required, you may either write the equations **neatly by hand** or **format them properly** using a computer text-setting tool (e.g. in Word using the Equation Editor, Mathematica, or some other math-typing tool). If a number of very similar repetitive calculations are necessary, you should only show one example calculation.

When showing your calculations make sure you always:

- **define all symbols** used, e.g. m = mass of ball; v_o = initial speed of glider, etc.,

- **specify the units** of all measured quantities, including the slopes and intercept of plotted lines, unless they are unitless,

- take care to use a reasonable number of **significant digits.**.

A quick note about typing your mathematical work vs. writing it out by hand. While you are absolutely allowed to do whichever you are most comfortable with - especially for those of you continuing on in STEM related fields - I would like to comment that learning to use math typing tools can be cumbersome at first, but it is absolutely a required skill if you have any desire to continue on in scientific or technical field, so now is good time to start learning!

III. Raw Data

Present data cleanly and clearly. Whenever appropriate, present data in chart or tabular form. If you have handwritten raw data records, staple them to the back of your report as an appendix.

- **Give your data tables a title** so it is clear what the data refer to.

- **Specify the units** of measured quantities and take care to **use a reasonable number of significant digits.**

- When possible, **estimate the uncertainty** in a measured quantity. For example, if you are recording a length measurement of 0.500 m that you believe is accurate to within 2 mm, write: `length of track =` $L = 0.500 \pm 0.002$ `m`.

IV. Working Together

You are encouraged to work together on lab reports and may consult with anyone or any book that you may find helpful. However, **data may only be shared among lab partners who were *both* present when the data was taken.** You may not take data and share it with someone that was not there or request that someone do this for you - this is an Honor Code violation. **Your final write-up must be your own unique product - typed by yourself without any other draft report to help you.** In particular, duplicate reports, even from lab partners, are not acceptable and will be viewed as a violation of the Honor Code.

Please feel free to consult me if you have questions during my office hours or whenever I am in my office for help with any aspect of your laboratory experiment or report. If you have a hard time finding me, please don't hesitate to contact me during lab or by email and make an appointment.

V. Experimental Accuracy

The experiments in this course generally give results that are accurate to better than $\pm 10\%$ to the accepted values. If your experimental results differ form the expected values by significantly more, say 40%, then you likely have made an error in your calculations or a significant mistake in the lab procedure. In such a case, you should recheck your calculations or return to the laboratory and repeat the required measurements. The laboratory will be open ever weekday from about 8AM until 5PM or so, often much later. You additionally have access by calling campus safety anytime.

VI. Preparing plots

All plots must be prepared using computer software such as Excel, Mathematica, or something similar. Plots must have a title and labels for the x- and y-axes, including the units of the plotted quantities. Do not connect the data points with line segments and do not attempt to draw a best fit line by eye. If the data set is linear, you should use a computer application (hopefully whatever you used to plot the data) to fit a straight line to your data similar to the process explained below for how to do so in Excel. Directions for using Excel will often be provided.

Instructions for Preparing Plots using Excel

1. Type or copy-and-paste data into columns in Excel.

2. Click-and-drag to select the data, then choose `Insert`, then click the `Scatter Plot` icon on the menu bar, then select the scatter plot with markers only from the drop-down menu.

3. With the plot selected, click the `Layout` tab under `Chart Tools`. You can then click appropriate icons to add a chart title and axis labels. Click `Gridlines` and select `none` to eliminate gridlines.

4. To add a linear regression or fit line to your plot, click `Trendline`, then `More trendline options`. In the popup dialog box, choose type `Linear` and check the boxes to `Display equation on chart` and `Display R-squared value on chart`. The R-squared value gives an indication of the linearity of your data; R-squared = 1 for perfectly linear data. Be sure to show sufficient digits so that the deviation of your value from 1 can be ascertained. Be sure to show a reasonable number of significant digits in the slope and y-intercept given on the plot. You can format the number of digits displayed by right-clicking on the trendline equation displayed on your graph and selecting the `Format` option.

5. **Not all data is appropriate to apply a linear fit to. Make sure you are plotting data that you *expect* a linear relationship for before going through this procedure!!**

Calculations in Excel

Often in this course you will want to create a new data column containing values calculated using the values contained in other columns. You can, and should, do this in an automated way. When you click on a cell in Excel in the new column a formula bar should appear somewhere near the top of the window. In that formula bar is where you will want to enter the formula for whatever calculation you would like perform. Details on creating formulas can be found in the `Help` documentation in Excel, but a couple of simple examples are given below:

```
= A1*2+1                (Doubles the value in cell A1 and adds one)
=(A1^2+B1^2)^0.5        (Adds the squared values in cells A1 and B1 and takes the square root.)
```

Note that **formulas always start with the equals sign =**. After having typed a formula for one cell, you can copy-and-paste it into all similar cells (Excel automatically understands that it should use cells in the appropriate row for each calculation) by just clicking and dragging a box over all the appropriate cells.