Lab Report Template

1 Title page

Must include:

- The name of the lab
- your name, your group members names, and the TA's name
- the course number and lab section (i.e. ENPH 131 EU01)
- the date
- Remember to number the pages of your report!

2 Introduction

A good introduction should be structured as follows:

- Intro sentence. Do not begin with "the purpose of this lab is" or "In this lab we will". These are not introductory sentences.
- A brief description of the physics principles that will be used, names of historical experiments and/or scientists. ($\sim$ 2-3 sentences)
- A brief explanation of the theory involved and the relationship between variables the theory describes. ($\sim$ 4-5 sentences)
- Statement of all relevant equations, defining all variables and constants and including units. Equations should be placed underneath text. Remember to number each equation, making it easy to reference them throughout your report.

3 Experimental Method

In this section you need to describe how the lab was set up and how you went about collecting your data. Someone should be able to duplicate the lab from your description in this section. A good method section should be structured as follows:

- Briefly describe how the lab equipment was set up or prepped for use ($\sim$ 2-3 sentences).
- Include a figure of the apparatus (take a picture with your phone). It is a good idea to label important pieces on the figure to aid in your description of the equipment.
- Briefly describe how you collected your data. This part may be in point form, full sentences or a combination of the two. *This does not mean that you copy the procedure from the manual.*
- Make sure to briefly explain the purpose of this data collection (i.e. what quantities you will be using the data to calculate).

4 Results

The results section should be structured as follows:

- Present raw data in tabular form, figures (plots), mathematical calculations and error analysis. This should be done in order of the procedure in the lab manual (i.e. each procedure step should be labelled clearly, followed by relevant data analysis corresponding to the procedure step).

  All tables must include:

  - a useful title involving the variables measured and the subject of the measurement.
    (i.e. Table 1: Distance and time measurements for a car moving on an air track)
  - Column labels including the variable symbol (or name) and units.
    (i.e. Velocity (m/s) or v (m/s))
  - include errors in each variable after the variable itself (if required) (i.e. v (m/s) | δv (m/s)). If the error remains constant you need not put the quantity in another column. This constant value can be displayed in the column header along with the variable name. Errors can be calculated using the equations provided below (they are also in the lab manual yellow pages).

Table 1: Error Equations

function (f)	δf
x	δx
x^n	$\lvert nx^{n-1}\delta x\rvert$
xy	$\lvert f\rvert \bullet \left[\frac{\delta x}{\lvert x\rvert} + \frac{\delta y}{\lvert y\rvert}\right]$
x/y	$\lvert f\rvert \bullet \left[\frac{\delta x}{\lvert x\rvert} + \frac{\delta y}{\lvert y\rvert}\right]$
xyz^n	$\lvert f\rvert \bullet \left[\frac{\delta x}{\lvert x\rvert} + \frac{\delta y}{\lvert y\rvert} + \frac{n\delta z}{\lvert z\rvert}\right]$

  If you are comfortable with taking partial derivatives you may use the following as an alternative to calculate relative error.

$$\delta f = \sum \frac{\partial f}{\partial x_i}\delta_i \;\Rightarrow\; \text{if} : f = \frac{x}{y} \;\text{ then} : \delta f = \frac{\partial f}{\partial x}\delta x + \frac{\partial f}{\partial y}\delta y$$

  - Sample calculations and sample error analysis calculations (if required) should be located below each table. You must show all your work (i.e. Begin with either the original error propagation formula provided in the lab manual or the calculus based one above. Next, plug in specific variables related to your calculation. Finally, plug in numbers and calculate the result)
  - If at anytime during the lab you are using a variable (or some function of more than one variable) the quantity should be in a table!

  All figures must include:

  - a useful title involving the variables measured and the subject of the measurement.
    (i.e. Figure 1: Velocity vs. time for a falling mass)
  - Axis labels including the name of the variable and units. (i.e. distance (cm/s))

  - Following each plot, include any relevant analysis pertaining to the relationship you have plotted (i.e. calculations of slope and intercept).
  - if your data is fit using a trend line, the equation of the trend line must be placed on the plot.

- Finally, complete what is asked of you in the Analysis section in the lab manual. Each question should be numbered, include a sentence describing what your calculating, the mathematical steps (show all your work!) and either a clearly circled answer or a final sentence stating your answer to the question.

5 Discussion

The discussion section involves your interpretation of the results and error analysis. You should think of this section as the **MOST IMPORTANT** part of your report. This section should be structured as follows:

- First, begin by explaining what your results mean in the context of the experiment (i.e. Do your results corroborate the theory? Do the experimental value(s) calculated make logical and physical sense?).

- Second, explain whether your results match the theory. This should include a calculation of percent error,

$$\%error = \left(\frac{\text{experimental} - \text{theoretical}}{\text{theoretical}}\right) \bullet 100$$

  if applicable. This equation is only to be used if you are comparing an experimentally derived value to a known or calculated theoretical value.

- Lastly, explain possible sources of error (i.e. friction, air resistance, mechanical error in the apparatus, human measurement error etc.) present in the experiment. Make sure to discuss both major and minor sources of error and the degree to which they effected your results. Note: You should treat the discussion of your sources of error as one of the most important part of your lab report!

6 Conclusion

The conclusion should be a short summary of your results and their meaning. A conclusion should be structured as follows,

- State purpose of experiment ($\sim$ 1-2 sentences).

- Briefly summarize important results and their meaning in the context of the experiment. Did your results follow the expected pattern?($\sim$ 4-5 sentences).

- Discuss problems encountered and possible solutions to these problems ($\sim$ 3-5 sentences). Try to find solutions that either use the material provided to you (i.e. changes to the experimental method) or involve materials that are readily available to you in an undergraduate physics lab (i.e. "perform the experiment in a vacuum" is not an logical solution).

- End with a concluding sentence. "Overall this lab was successful" is not a concluding sentence.

NOTE THAT SOME OF THE PARTS OF THIS TEMPLATE ARE NOT ALWAYS APPLICABLE TO EVERY LAB REPORT (I.E. IF THE LAB MANUAL DOES NOT TELL YOU TO CALCULATE ERROR THEN YOU DONT NEED TO!). IF YOU ARE UNSURE PLEASE ASK ME FOR CLARIFICATION.