Your objective in filing a report on one of our experiments is to briefly but fully describe it. It should be developed in much the same way as an essay: starting from a general introduction, moving through the particulars and driving to a conclusion. The difference is that we will use standard headings and much of the information can be expressed mathematically rather than in text.

Your intended reader is someone who knows nothing about the experiment, not your instructor or a classmate. You should “walk” the reader through the report. For instance, when you perform a calculation you should tell the reader what you are doing and why.

However, you can assume the reader is knowledgeable about physics in general and you need not explain every detail. For instance, calculating a percent error is standard practice and requires no explanation.

The following is the format we will use.

I. Purpose

A one-paragraph introduction stating what the experiment is about and what you will do in the experiment. Be specific, not broad:

- In this experiment, we measured . . . (what did you actually measure?)
- We tested the validity of Hooke’s Law by . . . (how did you do it?)
- We determined the permeability of free space using . . . (what did you use to do this?)

II. Principles & Theory

First, explain the idea of the experiment. Put it into context: what do we know, what do we need to find out. Explain briefly and in general terms how the measurement, test or determination will be accomplished. One or two short paragraphs will suffice.

Next, you should derive any mathematical expressions you will use in the experiment. Start with a definition or a basic principle and derive an equation that expresses the idea of the experiment mathematically. You will use this theoretical expression to make predictions about the experiment.
For instance, in Atwood’s Machine we will test how well Newton’s Laws predict the motion of the system. Atwood’s Machine consists of two masses hung over a pulley, so that one mass opposes the motion of the other.

We will test Newton’s Laws by comparing the measured acceleration of the system with that predicted by theory. In your report, you should start with \( F=ma \) and derive an expression for \( a_{\text{theory}} \), the predicted acceleration.

In the experiment, we will measure the distance and time of travel of the system, from which we can calculate the actual (experimental) acceleration. In your report, you need to derive an expression for \( a_{\text{experimental}} \), using the definitions of velocity and acceleration.

For this example, the basic principles are:

\[
F_{\text{net}} = ma \quad \text{(Newton’s 2nd law of motion)}
\]

\[
W = mg \quad \text{(Empirical force law for weight)}
\]

You don’t derive these, they are given.

From these you would derive:

\[
a_{\text{Theory}} = \frac{(M_1 - M_2)g}{(M_1 + M_2)}
\]

(predicted acceleration of Atwood’s Machine)

You must define the variables used: \( M_1 \) is not “the mass”. It is the mass of the down-going weight in Atwood’s Machine.

To analyze the experimental results you would use:

Given: \( v_{\text{average}} = \frac{\Delta x}{\Delta t} \quad a_{\text{average}} = \frac{\Delta v}{\Delta t} \)

Derived Result: \( a_{\text{experimental}} = \frac{2d}{t^2} \)

This expression depends on measured data: “d” and “t”. You should state explicitly what these variables stand for, and how they were measured.

To evaluate \( a_{\text{theory}} \), the masses used should be recorded, and the accepted value for the acceleration of gravity. To determine \( a_{\text{experimental}} \), the distances traveled and the time of travel for each mass set should be recorded. You should state this in your report.
You need not derive routine expressions, such as those for standard deviation, percent error, averaging, etc.

III. Equipment & Set-up

Very briefly describe the physical implementation of the experiment and the equipment used. Often, it is useful to include a diagram of the set-up. The diagram can serve to define the variables used in your equations.

Do not list the equipment; just state the type of equipment used. For instance in the Atwood's Machine, we will use a double pulley system with mass hangers and standard-size slotted masses.

IV. Data

Lab Notebook: List or tabulate all the data you take during the experiment. Do this on a separate page. No other writing goes on your data page but your recorded data. This is your official record of your experimental work. Your data page or pages should be authenticated (initialialed) by the instructor.

Lab Report: For a lab report not compiled in your lab notebook, you do not need a separate data section. You can tabulate your data along with your calculations & analysis. However, make sure all measurements and given data collected during the experiment(s) are listed in your report.

V. Calculations & Analysis

Here you make your numerical predictions, using your theoretical expression and perform whatever calculations are necessary to evaluate your results. Give one sample calculation in detail. The rest of your results can be tabulated.

Compare your predictions with the actual results. Take the percent error or percent difference (decide which is appropriate). Calculate average values, deviations, average deviations, standard deviations, etc. (if needed).

Determine the range of error in your predictions and the uncertainty in your experimental results.
If a graph is called for, use centimeter graph paper and paste or tape it in your lab notebook immediately following the relevant calculations or analysis. Include a copy or image of this in your report. Do not force the reader to hunt for the graph.

Graphs should be at least ½ page in size. Do not staple. Do not use the quad ruling in your lab notebook for graphs. Calculate the slope of your graph (if it is linear) and write down an equation of your graph based on experimental data. You may not use your calculator’s or computer’s graphing or data analysis utilities until you receive your instructor’s approval. For instance, you may be required to derive the equations for “linear regression” or “least squares fit” before you may use them.

For each objective in your experiments, write up your conclusions for that part immediately following the relevant data analysis.

VII. Conclusion

Briefly summarize the results of the experiment. Repeat your major findings or conclusions here. What do the results show or fail to show? What were the sources of error?