Physics 113/213 Laboratory Papers

As noted in the lab schedule, you will prepare a "formal" laboratory report for the experiment: "Conservation of Energy" (Lab 4). This report is due in class on **Monday Oct. 8**. In writing up your laboratory report you will follow the format of a scientific article. There is a standard, formal structure for such articles, which is described below. You may want to stop by the library and look at some journals such as "Physical Review" or "American Journal of Physics" to get a better idea of what this format looks like. In practice, minor deviations from the standard structure are common.

The goal of any scientific paper is to tell a coherent and interesting story to your readers: you want to describe what you did, why you did it, what you observed, and why your observations are interesting. In order to do this, you need to organize your paper so it conveys the necessary information clearly and conveniently. Consider your readers to be students in an introductory physics class at another college who have never performed the experiment you have done.

Your reports should be prepared using a computer word processor (double spaced), although any equations you use can be written in (neatly!) by hand. Also, any figures, graphs, and tables you include may be collected at the end of the report. They should be clearly labeled (i.e., Figure 1 or Table 3) and referred to as such in the text. Any figures included in your paper must be your own work (i.e., figures copied from the web are not acceptable).

The **standard format for a scientific article** is to divide it into multiple sections, typically labeled as follows: (1) Abstract, (2) Introduction, (3) Theory, (4) Apparatus & Methods, (5) Results & Data Analysis, (6) Discussion & Conclusions, and (7) References.

(1) **Abstract**: The abstract should be a clear, concise summary of the principal facts and conclusions of your experiment. In just a few sentences you want to describe the purpose of your investigation, just what was measured, and what conclusions you have drawn from the measurements. People usually decide whether or not they want to read a scientific article based on the abstract, so you want your abstract to be both complete and interesting! This is an extremely important part of any scientific paper.

(2) **Introduction:** The introduction should provide some background on the topic under investigation. Here you both want to frame your investigation in a broad context and discuss why the type of measurement being made is of interest. Some history on the subject may also be included. Your textbook should be a useful source for this section.

(3) **Theory:** The theory section contains a description of the theoretical principles and/or equations necessary to understand the experimental method and the data analysis. This could

include the theory being checked by the experiment or the theory behind the experimental procedure. All equations should be offset from the text as in

$$E = mc^2 \tag{1}$$

and numbered (as above) so they can be referred to later in your Results & Data Analysis section. Your equations for uncertainty propagation should be included in this section.

(4) **Apparatus & Methods:** This section describes, in standard paragraph form, both the experimental apparatus and methods used. A diagram of the apparatus is essential. Please note that this section is NOT intended to be a lab manual so DO NOT include step-by-step instructions! Rather, you should give a detailed description of the experimental setup (with reference to your diagram), explain how the experiment works, and state exactly what it is that you measure with the setup. You should also include what software (if any) was used in data acquisition and you should provide estimates of all experimental uncertainties which will be used in your data analysis.

(5) **Results & Data Analysis:** This is the most important section of the paper. It consists of a written description of what you observed in your experiment, tables and graphs that summarize the data collected, and finally your data analysis. You will need to explain how the equations presented in the theory section are used here to analyze your data. Also, you will need to propagate experimental uncertainties through all your calculations and your final results should be presented in the format: result±uncertainty units. (Here are some examples: 0.30±0.02 J or $(3.5\pm0.5)\text{x}10^{-3}$ m).

(6) **Discussion & Conclusions:** This section should relate your measured results to the purpose of the experiment. This is the time to discuss agreement or disagreement with other experiments or with theory. In this section you should also note any inconsistencies in your data, discuss possible contributions to error, and speculate on how the experimental methods might be modified to improve accuracy. Finally, you should note any general conclusions that can be drawn from your results.

(7) **References:** This section consists of a numbered list of ALL sources consulted during the experiment and during the writing of your paper. At a minimum, this section should include your testbook and the lab instruction and data analysis sections from this manual. References should be referred to in the body of your paper wherever appropriate. You can use either numbers (for example [1] or [Ref. 3]) or abbreviated citations such as (Lindenfeld and Brahmia, 2011) or (Moore, 2016).

Grading: Abstract=15% Intro=10% Theory=15% Procedure=15% Results=25% Discussion=15% Ref=5%