**Physics 203L** **Modern Physics Lab** **Spring 2017**


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| Class Mtgs: | Th 2:50-5:50 (TREX 272) | Instructor: | Daniel Robb |
| Office: | TREX 266B | Office Hours: | MWF 10-11, 2:30-4 |
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## Course Description:

Laboratory accompanying PHYS 203. A collection of experiments illustrating important principles and/or fundamental constants in modern physics, as well as several historical discussions surrounding experiments significant to the development of modern physics.

## Textbook:

- *no textbook required*

## Purpose of the Course:

Modern physics (i.e., the physics of primarily the 20th century) is the crown jewel of the introductory undergraduate sequence, and we are honored this semester to admire the many facets of its beauty. I endeavor to provide the proper atmosphere and avenues so that the principles are not trampled for the sake of analytical problem solving. That said, our lofty goal includes a balanced understanding of both the theoretical underpinnings of Modern Physics without sacrificing their beauty. A huge portion of the beauty of modern physics is that the principles are verified by experimental results. For aspiring scientists, the concepts and practice of writing are mostly uncharted waters, particularly where numeric values and uncertainties are incorporated. Scientific writing has its own guidelines and structure, and we intend to reinforce and refine the structure that you've learned to this point. The opportunity to reinforce and apply what is learned in the 203 course should be welcomed by each of you. Learning physics is an iterative process, and the laboratory serves this end as it provides a varied context. Moreover, the 203 Laboratory will also inform you about the process of science as seen through the lens of history and philosophy. Many of the ways that science is promoted do not actually cohere with the way science is carried out. Modern physics discoveries exemplify this discrepancy in many instances.

## Intended Learning Outcomes:

1. explore open-ended questions that highlight course-related phenomena.
2. challenge (and be challenged by) colleagues regarding their current understanding of physical concepts as they are implemented within the lab.
3. write paragraphs that pertain to physical phenomena, graphical results, and error uncertainties in a meaningful way.
4. design experimental testing of hypotheses in part and/or in full to meet the laboratory purpose(s).
5. deepen understanding and application of errors, both systematic and random, as they apply to physical results.
6. examine the historical context of scientific discovery to better understand the development of physics.

## Grading:

Your course grade will be composed of 10% for each of the 7 lab reports, and 10% for each of three reflections on a History and Philosophy of Science unit. Unless otherwise specified, written lab reports for each exercise are due two weeks from data completion. Reports should follow the section order presented below. As in PHYS 202, we will conduct all-electronic submission in MS Word via the Inquire site. Please note that a deduction of 10 points will occur for every day a lab is late past the specified due date; no credit is awarded for labs > 5 days late. A percentage breakdown of how the total grade is determined is as follows: Cover "page" (aka. Heading) 5%, Abstract 20%, Introduction 15%, Data and Results 40%, and Discussion 20%. Each required section of the lab is briefly described below. Please have a look at the sample lab posted on the Inquire pages as a guide as well as the lab writing rubric.

## Attendance Policy:

Since a portion of your grade in 203 depends on the laboratory, you must enroll in both the "lecture" and laboratory sections of 203. The lab starting and ending times are firm, although it may be possible to complete the lab before the published ending time. You will be allowed one late entrance to the lab up to 15 minutes after the set starting time, i.e., < 3:05. After the first 15 minutes, no one will be admitted without prerequisite authorization. Alternative arrangements (e.g., make-ups) will only be entertained as a result of a discussion with me beforehand or an emergency note (death, hospitalization, misdemeanor, etc.) signed by a governing official (medical doctor, parent, law enforcer, etc.).

## Academic Integrity:

The College academic integrity policies are vigorously enforced. Although you are encouraged to work in groups on your assignments, all work turned in for a grade must be your own. Please familiarize yourself with the College's academic integrity policies.

## Assignment descriptions:

*History & Philosophy of Science (HPS) Reflections:*
One of the reasons for creating a Modern Physics lab component was to provide an opportunity to discover how science is carried out. Too often we have viewed (and been taught) that science is a linear process, successive iterations between theory and experiment. We will take time to learn about actual episodes from HPS and you will reflect on them.

*Written Reports:*
We will focus our writing efforts on specific sections of the Laboratory Report. Below I have outlined a brief description of each one.You will also have a rubric to follow as you construct each section.

The following items must be included on every **Cover Page**: title of the experiment, date of the experiment, your name, and collaborators' names. Though trivial to complete, this information accurately identifies your work so that you can receive a grade.

The **Abstract** provides a brief summary of the entire report. This summary includes the purpose of the lab (i.e., the hypothesis), a short statement of the physical phenomena investigated, the principal numerical and/or qualitative result(s), and a concluding sentence of quantitative agreement/disagreement with the intended purpose.

An **Introduction** properly defines the concepts and background for the measurements and phenomena to be examined. While your Introduction does not need to be voluminous, a good introduction provides the reader enough information to ensure that you can carry out the experiment and that the reader can understand.

A neat and organized presentation of the **Data and Results** is important, which includes any graphs and calculations. Graphs must contain appropriate captions and labels with units, and equations need to be stated formally (i.e., in general form) before any values are inserted. All numerical values need units. Questions provided under this section in the lab handout do NOT need answering explicitly. Rather, they are meant to guide you as the lab is completed and the Discussion is written. When equations are used repetitively, they only need stating formally once.

Lastly, a concise **Discussion** (~ 2 paragraphs) should conclude each lab. Here again, the results should be stated and commented on as compared with established or expected values (if available). Also, an attempt to summarize the possible sources of error in your measurements and/or results should be included. In this section, you could discuss any questions from the handout asked within the (Discussion and/or the Results) section.

| Date | Topic | Activity Schedule |
|---|---|---|
| 16 Jan<br>18 Jan<br>20 Jan | **Relativity** | Introduction; Lab 1: The Oscilloscope |
| 23 Jan<br>25 Jan<br>27 Jan | | Lab 2: Error Analysis and Propagation of Error, Young's 2 Slit |
| 30 Jan<br>01 Feb<br>03 Feb | | Lab 3: Speed of Light I |
| 6 Feb<br>08 Feb<br>10 Feb | | Lab 4: Speed of Light II |
| 13-Feb<br>15-Feb<br>17-Feb | **Quantum Physics** | Lab 5: Photoelectric Effect |
| 20-Feb<br>22-Feb<br>24-Feb | | *Review: Exam 1* |
| 27-Feb<br>1-Mar<br>3-Mar | | HPS 1: Max Planck and Niels Bohr, in Perspective |
| 6-Mar<br>8-Mar<br>10-Mar | *No Classes – Spring Break* | |
| 13-Mar<br>15-Mar<br>17-Mar | | Lab 6: e/m ratio |
| 20-Mar<br>22-Mar<br>24-Mar | | HPS 2: Imagination and Creativity in Physics |
| 27-Mar<br>29-Mar<br>31-Mar | | HPS 3: Robert Millikan, in Perspective |
| 3-Apr<br>5-Apr<br>7-Apr | | *Review: Exam 2* |
| 10-Apr<br>12-Apr | **Nuclear Physics** | Lab 7: Radioactivity |
| 14-Apr | *No Classes – Good Friday* | |
| 17-Apr<br>19-Apr<br>21-Apr | | Make-up lab week |
| 24-Apr<br><br>1-May | | *Review: Final Exam*<br><br>**Final Exam 2 – 5 PM** |