Physics 203 Laboratory
Spring 2020

Meeting: Trexler 272 Time: THU 2:50–5:50
Instructor: Matthew C. Fleenor Office: Trexler 266D
email: fleenor@roanoke.edu webspace: Hours: W R 1.00 – 2.30 PM
http://faculty.roanoke.edu/fleenor/ or by appt.

Required Textbook: Required Textbook: An Introduction to Error Analysis, 2nd ed., J. Taylor (1997), University Science Books

Required Prerequisites: Physics 202

I. Components of Learning

There are several factors that make a course "good" (by good, I mean a healthy combination of the intellectual and the affective). Good courses are also clear about their essential components. Below is an attempt to be clear about how will I operate within PHYS 203L, as well as my expectations of a student who is enrolled in PHYS 203L.

Descriptions

Aspiration: 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 conceptual delicacy of the priniciples 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 as we plan to examine some of the context.

Intended Learning Outcomes

The successful student will–

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.

Attendance Policy

Since a portion of your grade in 203 (20%) 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

I want to foster a mutual respect for the classroom hours that we have together. Refer to the "Academic Integrity" page on the RC website– `http://roanoke.edu/A-Z_Index/Registrar/Policies_and Information/Academic_Integrity.htm`

Included here is an explanation of how violations of the College's academic integrity policy are handled.

Grading

Unless otherwise specified, written lab reports for each exercise are due two weeks from data completion. Typed reports are acceptable that follow in the order presented below. In the name of conserving paper, the course will (attempt to) conduct all-electronic submission in `PDF` only and grading via the `NQR` site. **Please note that a deduction of 10 points will occur for every day a lab is late past the specified due date, and 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. Although we will discuss lab writing throughout the course, please have a look at the sample lab posted on the `NQR` pages as a guide as well as the lab writing rubric. Most of us are accustom to doing writing and data analysis in `MS` products. I would like for each of you to learn something new about presentation of data and scientific writing this semester, therefore I would like for you to use some other package than `MS` for at least ONE of your reports.

II. Modes of Learning

Rubric

Your grade is determined according to the following distribution:

Reports (5)	80%	Reflections (3)	20%

Descriptions

History & Philosophy of Science (HPS) Reflection

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, though we will examine and discuss the constituencies of each section. 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, 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, and equations need to be stated formally (i.e., in general form) before any values are inserted. All values need units. Any 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, and then the results can be stated without justification (possibly just reference).

Lastly, a concise `Discussion` (~2 paragraphs) should conclude each lab. Here again, the results should be stated and commented on as compared with the established 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.

III. Lab Outline

There is an attached outline of the lab sequencing, including the proposed historical episodes. We will attempt to follow this sequence closely as it also adheres to the sequence of topics in the course.

Physics 203 Laboratory: SPR 2020

Week	Date	Topic	Activity Schedule
1	13-Jan 15-Jan 17-Jan	**Unexpected Results**	HPS 1: Imagination & Creativity in Physics
2	20-Jan 22-Jan 24-Jan		HPS 2: Robert Millikan, In Perspective *(Not Meeting, Assignment Outside of Class)*
3	27-Jan 29-Jan 31-Jan		Lab 1: Charge-to-Mass Ratio (e/m) (Collaborative: Abstract, Introduction, Data & Results)
4	3-Feb 5-Feb 7-Feb	**Quantum Theory**	Lab 2: Photoelectric Effect (Collaborative: Abstract, Data & Results, Discussion)
5	10-Feb 12-Feb 14-Feb		HPS 3: Max Planck and Neils Bohr, in Perspective
6	17-Feb 19-Feb 21-Feb		Lab 3: Error Analysis and Propagation of Error, Young's 2 Slit (Full Lab)
7	24-Feb 26-Feb 28-Feb		HPS 4: Interpretations of Quantum Mechanics
8	2-Mar 4-Mar 6-Mar	*No Classes – Spring Break*	
9	9-Mar 11-Mar 13-Mar		Lab 4: Function Generators & Oscilloscopes
10	16-Mar 18-Mar 20-Mar	**Special Relativity**	Lab 5: Circuits, Oscillators, and Oscilloscopes (Full Lab)
11	23-Mar 25-Mar 27-Mar		HPS 5: Einstein, Michelson-Morley, Theory & Experiment
12	30-Mar 1-Apr 3-Apr		Lab 6: Speed of Light I and II (Full Lab)
13	6-Apr 8-Apr 10-Apr		*Speed of Light Labs (cont'd)* No Classes – Good Friday

14	13-Apr 15-Apr 17-Apr	**Further Topics**	Lab 7: Radioactivity, e- Diffraction, Oil Drop Experiment (Summary, Qualitative)
	20-Apr		