Physics 203 Laboratory
Spring 2022

Meeting: Trexler 272 Time: T 2:50–5:50pm
Instructor: Daniel Hickox-Young (Dr. H-Y) Office: Trexler 266B
email: hickoxyoung@roanoke.edu zoom: https://roanoke-edu.zoom.us/my/hickoxyoung
Office Hours: MWF 1:00–3:00pm and by appt (https://calendly.com/hickoxyoung)

Required Textbook: None 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 principals 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

Because we are in the season of a global pandemic (COVID), please understand and abide by the following:

Face coverings/masks must be worn over the mouth and nose by all students and instructors in classrooms and hallways of academic buildings. By wearing face coverings, we protect our college community and its most vulnerable members. Students who come to class without a face mask that is being worn properly will be asked to leave and will be readmitted only after they are wearing one. The bookstore has masks available should you need to purchase one, although I would strongly encourage you to seek out a KN95 or surgical mask for better protection.

Also, if you have a temperature of 100.4 or higher or other coronavirus symptoms, don't come to class. Call Health Services IMMEDIATELY. Do not come to class or go to any public area on campus. Do keep up with all readings, assignments, and deadlines. In order for your absence to be excused, you must give Health Services permission to notify me that you have consulted them about coronavirus symptoms. If Health Services informs you that you should isolate and not attend class for multiple days or weeks, inform me so that we can make a plan to keep you current in the course. All absences caused by consultation with Health Services about coronavirus symptoms or isolation ordered by Health Services will be excused.

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 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 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:

Participation	20%
Biography Presentation	10%
Lab Reports	70%

Descriptions

History & Philosophy of Science (HPS) Biography Presentation

We will discuss many historical figures throughout the HPS section of this course, highlighting their contributions to and perspectives on physics and scientific inquiry in general. Each student will select one of these figures (or another of their choosing, with my approval) and give a 10 minute oral presentation. The content of this presentation is somewhat open-ended. It may focus on the downstream consequences of one of their most significant findings, place their life and work in historical context, or simply offer a perspective on their contributions to physics. Whichever the topic, the presentation should be well-researched (with citations), using materials from outside the course content.

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.

PHYS 104: Fundamental Physics II, Spring 2022- Daily Schedule

The following schedule outlines the tentative timeline for the covered topics and exam dates:

Day	Topic	Reading	Due	Laboratory (On Tuesdays)
UNIT 1: Unexpected Experiments				
19 Jan	Introduction to the course	--		HPS 1: Imagination and Creativity
21 Jan	Classical physics	1.1-1.3		
24 Jan	Atomic theory, & unresolved questions	1.4-1.6		
26 Jan	The Electron and Its Charge	3.1-3.2		Lab 1: e/m ratio
28 Jan	Line spectra	3.3-3.4		
31 Jan	Blackbody radiation	3.5		
02 Feb	Photoelectric effect	3.6	PS 1	HPS 2: Robert Millikan, in perspective
04 Feb	Compton effect	3.8		
07 Feb	Rutherford scattering	4.1-4.3		
09 Feb	The Bohr model	4.4-4.5	PS 2	Lab 2: Photoelectric Effect
11 Feb	Review/catchup			
14 Feb	TEST 1			
UNIT 2: Quantum Theory				
16 Feb	De Broglie waves and scattering	5.1-5.3		HPS 3: Planck and Bohr, in perspective
18 Feb	The Uncertainty Principle	5.4-5.6		
21 Feb	Probability and wavefunctions	5.7-5.8		
23 Feb	The Schrodinger equation	6.1		Lab 3: Young's 2 Slit (w/ Error Analysis)
25 Feb	Expectation values	6.2		
28 Feb	Infinite square wells	6.3, 6.5		
02 Mar	Barriers and tunneling	6.7	PS 3	HPS 4: Interpretations of QM
04 Mar	Alpha decay and scanning microscopes	6.7		
07-11 MAR – SPRING BREAK				
14 Mar	The hydrogen atom	7.1-7.2		
16 Mar	Quantum numbers	7.3		Lab 4 Function Generator/Oscilloscope
18 Mar	Magnetic effects and intrinsic spin	7.4,7.5	PS 4	
21 Mar	Review/catchup			

23 Mar	TEST 2			Lab 5: Circuits/Oscillators/Oscilloscopes
UNIT 3: Special Relativity				
25 Mar	The ether and Michelson-Morley	2.1-2.2		
28 Mar	Einstein postulates; Lorentz transformation	2.3,2.4		
30 Mar	Time dilation and length contraction	2.5,2.6		HPS 5: Einstein and Michelson-Morley
01 Apr	Experimental verifications	2.7		
04 Apr	The twin paradox and spacetime	2.8,2.9		
06 Apr	Relativistic momentum and energy	2.11,2.12		Lab 6: Speed of Light I and II
08 Apr	Relativistic collisions	2.11,2.12	PS 5	
11 Apr	Review/catchup			
13 Apr	TEST 3			Speed of Light Labs (cont'd)
15 APR – GOOD FRIDAY – NO CLASS				
18 Apr	Research on final topic in groups			
20 Apr	Research on final topic in groups			Lab 7: Radioactivity, Electron
22 Apr	Research on final topic in groups			Diffraction, Oil Drop Experiment
25 Apr	Research on final topic in groups			
26 Apr	Preparation of final presentations			
02 May	2:00pm-5:00pm	Final Presentation		