PHYS 181Lab - General Physics Lab (1 credit)

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Office Hours T, R 9:00 – 10:00 am
Laboratory Meetings: All sections meet in Lind 202
181Lab-03: T 3:00 pm to 4:50 pm
181Lab-04: T 5:00 pm to 6:50 pm

Course Objectives:
1. Develop appreciation of and facility for the practice of experimental science.
2. Develop skills in the oral and written communication of physics concepts.

Course Outcomes:
- Demonstrate knowledge of key ideas associated with the topics listed in the PHYS 181 syllabus through oral and written communication.
- Demonstrate understanding of correspondence between physical systems and their mathematical descriptions.
- Demonstrate through oral and written communication proficiency and prudence in the use of the scientific method.

Lab Structure: Throughout most of the quarter, this course is not set up like most introductory labs in that there are no prescribed labs and no step-by-step procedures for you to follow. (The first week will be designed to help you refine the skills needed for creating your own labs.) Your group designs each lab in consultation with the lab instructor. You decide what system to investigate, how to investigate it, what questions to answer, what conclusions to draw, etc. The job of the lab instructor is provide guidance when you are stuck and to give you feedback on your lab work. S/he will not tell you specifically what to do. You must take responsibility for learning the concepts in lab. Many students underestimate their ability to ask and answer questions about a system or phenomenon. You have the ability to succeed in this lab. See "Hints for productive experiments" at the end of the syllabus for more information.

Lab Group Structure: You will work in groups of three or four people assigned by the instructor. You will remain in these groups for the entire quarter. Lab work needs to be a cooperative endeavor. Each week the instructor will assign specific roles for each group member. Focusing on a single role each week will allow you to better concentrate on the physics concepts you are studying. For example, you won't have to worry about writing everything down, making sure your partners stay on task and know what's happening on top of understanding the concepts. The important cognitive will be the responsibility of different group members from week to week. Roles:
- Recorder: maintains the logbook for the group
- Moderator: insures the group stays productively on-task; insures that consensus is reached for group actions; insures that group members are all engaged
- Skeptic: questions assumptions; raises the difficult questions; asks for explanations; requires convincing and compelling arguments
- Checker: makes sure each group member understands what is being done and can explain it

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Group Logbook: Your group logbook is a place to record the details of the entire process through which you have come to an understanding. Thoughts, hypotheses, descriptions of experimental setup, sketches, graphs, modifications to experiments, modifications to hypotheses, notes of discussions within a group or with individuals external to the group, notes about established theories, calculations, data tables, and conclusions are all appropriate for inclusion in the logbook. As you might guess from this extended list: If in doubt, put it in!! The final test is this: Can someone who has no idea what you are doing, pick up your logbook and from what you have written, understand the complete logical development of your investigation, and completely reproduce your experiments and your results??? Make sure recorders name is clearly marked at the beginning of the weeks entry. All other group members need to initial the logbook at the end of each weekly entry. All groups are expected to perform at least some of their analysis with the computers available in the lab.
Each logbook grade will be based on three things:
1. Are there enough details for reproducibility? (i.e., Could another group do your experiment?)
2. Is the experiment productive? (i.e., Is your hypothesis good? Is your procedure effective?)
3. Is the group making progress? (i.e., Did you advance from the previous week?)

Each week, the logbook entry will be graded on a check plus, check, check minus system for the three aspects listed above. Scores will range from 10 (3 check plusses) to 5 (3 check minuses). Logbooks are due at the end of each lab period.

Weekly Abstract: Every student except the recorder will turn in a one page abstract. The abstract is a brief written report that answers the following three questions:
1. What did we do? (What is the nature of the experiment? What specific things did we do today?)
2. How did we do it? (What apparatus, analytical techniques, experimental methods did we use?)
3. What did we find out? (What was learned today?)

Abstracts need to be clear, well written, complete and brief (NO MORE than a single page). Sketches of experimental setups and graphs can and should be included. The abstracts will be graded using a check plus (10 points), check (8.5), check minus (7) system.
Abstracts are due in lecture on the day after lab but you may turn them in at the end of the lab period. You are allowed to turn in one abstract up to one week late. Otherwise, late abstracts are not accepted.

Weekly lab assessment:
Recorder's grade: 2 x logbook grade
All other group member's grade: logbook grade + abstract grade
You may make up <u>one</u> lab without penalty. A make-up lab consists of doing an activity or portion of an activity that builds on something your group did during a prior lab period. The make-up lab must be done before the missed lab or within two weeks after the missed lab.

Formal Lab Report: There will be a single formal laboratory report due at the beginning of the last lab period. The report will be based on work that was carried out during the weekly lab periods. Each individual will determine the lab work that she or he reports. Members of a lab group do NOT need to report on the same work, and the work reported may have been carried out over one or several lab periods. Late reports will be penalized 4 points for every class day they are late.

PHYS 181Lab - General Physics Lab (1 credit)

The **minimum** components of the lab report are:
Title page: This page includes the title of the lab (the title should be interesting, brief, and clearly identify the subject of the work), the author, and the date.

Abstract: The abstract is typically a one-paragraph summary of the report. It should briefly identify the subject of the report, the methods used in the study, and your conclusions: what you did, how you did it, what you found out. The abstract must be self-contained and understandable without further review of the report. Please put this on a page by itself. (You do not need to fill the page with the abstract.)

Introduction: This is an introduction to the problem, system, or principle that is the focus of the report. A good introduction provides enough of a background, that a reader unfamiliar with the report's topic will be able to understand and evaluate the report without referring to other sources. This is the appropriate place to expound on the hypothesis that drew you into this particular study. Describe how you came up with the hypothesis and convince the reader it is interesting.

Hints for writing an effective introduction

It is difficult to write a good introduction. But, the introduction may be the most important part to write well from the reader's standpoint. If the introduction is effective, the reader will gain interested in the report and will be more likely to forgive small errors in the rest of the paper.

Criteria for an **acceptable** introduction

- Clearly states the purpose (hypothesis) of the experiment
- Clearly presents some key ideas pertinent to understanding the experiment

Criteria for a **good** introduction

- Clearly states the purpose (hypothesis) of the experiment
- Justifies the hypothesis in a manner consistent with the course content
- Clearly points out why the study is interesting from the standpoint of physical principles (gives a historical background, relates the experiment to every day life, etc.)
- Presents the key ideas pertinent to understanding the experiment in a clear, narrative style

Description of Apparatus: This section should list and describe the apparatus that was used in the study, and describe how the apparatus was arranged. Simple, clearly labeled diagrams are an important part of this section. You may also want to discuss difficulties that you encountered with the apparatus during the performance of your experiments.

Experimental Procedure: How did you gather your raw data? The experimental procedure section **should provide enough information about your methods that a reader could readily reproduce the experiment**. You may also want to discuss difficulties that you encountered with your procedures during the performance of the experiments.

Results: This section should present the results of your experiment. Data should be presented in graphs or tables. The results you present, and the manner in which you present them, should be meaningful to the reader. Sample calculations should be included to illustrate the manner in which your results were obtained. **DO NOT FORGET UNCERTAINTIES!** Identify the

sources of uncertainties in your measurements. Discuss how you obtained the uncertainties associated with your measurements.

Analysis: Discuss, **IN DETAIL**, the principal theories, models, or relationships that apply to the system you studied (i.e., draw the force diagrams, create and solve the appropriate force and energy equations, etc.). How do the results that you obtained compare with accepted theories, models and relationships, or the findings of other researchers? Make certain to point out any departures of your system from the conditions assumed by accepted theories, models, or relationships - do **not** confuse disagreement with theory due to these departures with disagreement caused by an invalid theory. Are your results consistent with accepted theory? Remember that the departure of experimental results from theory has been the source of nearly every great scientific discovery. (It would be prudent to temper enthusiasm for this principle with recognition of the vast amounts of data that are consistent with certain theories). Discuss **what you have concluded** as a result of this study. Note how the study that you have performed could be improved or expanded, and how the conclusions you have reached could be further tested (e.g., what other experiments could be performed to develop a better understanding of the area you investigated?).

Formal Report Grade: These sections must be prepared in such a way that they are elements supporting a **unified** discourse. Your lab report will be graded with weight given to each the following four areas:

_____ Basic Writing (6 points)
- Spelling, verb tense, etc. (single word issues) (~3)
- Sentence structure, paragraph structure (~3)

_____ Analysis (14 points)
- Clear, complete derivation/description of theory with relationship to "real life" (~4)
- Clear, complete justification of hypothesis, based on sound reasoning (~2)
- Clear, complete summary of how results fit theory (~4)
- Clear and definite conclusion based on results (~4)

_____ Clarity (6 points)
- Unified, one paragraph and section leads to the next (~3)
- Well organized, the reader knows how current section fits in the "big picture" (~3)

_____ Content (14 points)
- Clear and informative diagrams, graphs and tables (~3)
- All aspects of lab explained completely, used correct terminology (~3)
- Detailed description of error (~2)
- Real experiment with a testable hypothesis (~2)
- Evidence that experiment was interesting and productive (~2)
- Complete and accurate abstract (~2)

_____ Total

Hints for productive experiments:

1. Formulate experiments around a hypothesis whose basis is the relationship between parameters of a system (e.g., we hypothesize that there is a linear relationship between the length of Bruce's tie and the day of the week.)
2. Limit the scope of experiments (e.g., we are only going to investigate the relationship between the length of Bruce's tie and the day of the week - we will NOT consider additional

parameters such as the color of Bruce's shirt, the color of Bruce's pants, the number of pens in Bruce's pocket). Note that as you develop an understanding of how two parameters are related you can always expand an investigation to include a third parameter and then a fourth and so on.
3. Make sure that the data that your experiment generates is sufficient for evaluating your hypothesis (e.g., a hypothesis that there is linear relationship between the length of Bruce's tie and the day of the week cannot be evaluated by measuring his weight on Tuesday.)
4. Think very carefully about what you are going to do with the data in order to develop an understanding of the system you are investigating (e.g., we are going to make a plot with the day of the week on the horizontal axis and the length of Bruce's tie on the vertical axis - if our hypothesis is correct this plot should be a straight line).
5. NEVER make a conclusion without citing the experimental evidence that supports the conclusion (e.g. the graph on page 7 of the logbook shows a linear best fit to our data and it is qualitatively an inaccurate description of our data - therefore we conclude that our data is not consistent with a linear relationship between the length of Bruce's tie and the day of the week).
6. Compare the results to established theory (e.g., our physics textbook indicates that there IS a linear relationship between the length of Bruce's tie and the day of the week; we suspect that our results were inconsistent with that because we did not control the color of his shirt - we are planning another experiment that controls this variable.)

Grading Specifics	**Relative Weight**
Weekly lab assessment	50%
Formal lab report	50%
Total	100%

Final Grades for the course will be calculated as follows:

		A	92 - 100%	A-	90 - 91%
B+	88 - 89%	B	82 - 87%	B-	80 - 81%
C+	78 - 79%	C	72 - 77%	C-	70 - 71%
D+	68 - 69%	D	62 - 67%	D-	60 - 61%
		F	<60%		