Phys 2014 **General Physics Lab I** **Spring 2019**

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Co-requisites: PHYS 2013 General Physics I
Text: *General Physics I-II Laboratory Manual* available in the UMD Bookstore.
Course info at: http://www.d.umn.edu/∼jmaps/phys2014/

PHYS 2014 is the laboratory portion of the calculus-based General Physics I. PHYS 2014 is to be taken concurrently with PHYS 2013, the lecture portion of General Physics I. Separate letter grades will be assigned for your work in PHYS 2013 and PHYS 2014.

Course content and learning outcomes PHYS 2013 taken with PHYS 2014 constitutes a course with lab in the Natural Sciences category. The course is intended to provide practical experience in making measurements, keeping reliable and useful lab records, and analyzing and interpreting data in the context of the basic physical laws developed in the lecture course, Phys 2013. This includes the use of software to acquire, graph, and analyze data. It provides experience in the collection, analysis, and presentation of data, including in graphical format, problem-solving in a practical context, and interpretation and summarization of results in terms of fundamental physical laws in appropriate technical prose.

Over the course students will demonstrate the learning outcomes for the liberal education/natural sciences learning outcomes by: (1) applying concepts and principles that comprise a foundational knowledge of physics, (2) explaining how scientific inquiry is used to address questions about natural phenomena, and (3) applying aspects of the scientific method to address questions about natural phenomena.

This course also addresses ABET student outcomes (a) - ability to apply knowledge of mathematics, science and engineering; (b) - ability to design and conduct experiments, as well as to analyze and interpret data; (d) - ability to function on multidisciplinary teams; (k) - ability to use the techniques, skills and modern engineering tools necessary for engineering practice. Outcome (b) is assessed in the course.

You will typically work in groups of 2 or 3 on the same apparatus. You cooperate in designing procedures and taking data. Each team member must make a record of all data in a laboratory notebook as the experiment is conducted. The data pages of the notebook must be initialed and dated by the lab instructor before you leave the laboratory. You are expected to carry out basic analysis before leaving lab to ensure all necessary data was recorded and the data collected is good. Final analysis will be done outside lab.

When you come to lab please bring:

- the lab manual;
- your completed pre-lab exercise for the lab – these are in the manual as the last pages of each lab;
- a calculator;
- a USB drive for storing any data collected via computer;
- your lab notebook – see below.

At the first laboratory meeting you must have a suitable notebook. Suitable notebooks are stocked in the bookstore. Notebooks are acceptable if they meet the following specifications:

- Size of 8 x 10 inches (or slightly less);
- Sewn binding or strong glued binding — *not* spiral or loose-leaf;
- Quad-ruled (graph paper grid — *not* lined for composition).

The labs may be performed in a sequence different than the order in the lab manual. Your lab instructor can tell you the next lab to be performed each week. Links to the schedule of labs may be found at http://physics.d.umn.edu/ along with other lab information.

Resources Some data analysis outside of lab will be necessary, and you may install the software used in lab on your own computer for this purpose. The software used to collect, analyze, and graph data for this

course may be downloaded by students taking Phys 2014 from http://physics.d.umn.edu/physlabs/ (Off-campus access to this server may require the University's VPN software.)

Grading Course grades will be based on your lab notebook and a written final exam. The associated weights are:

- Lab notebook 80%
- Lab final exam 20% (Date TBA)

The preliminary grading scale is:
$> 90\% \Rightarrow$(A-,A); $> 80\% \Rightarrow$(B-,B,B+); $> 70\% \Rightarrow$(C-,C,C+); $> 60\% \Rightarrow$(D,D+).
This scale is subject to adjustment *up or down* by lab section to account for grading variations among lab instructors.

Missed labs An *excused* absence may be made up during designated make-up periods, e.g. the last week of classes or other designated times. You must notify the teaching assistant in advance of the excused absence or, in the case of emergency, as soon after as practical. Make-up of more than one excused absence must be discussed with the coordinating instructor. Excused absences are defined by University policy. Unexcused absences or failure to submit the lab notebook for grading after performing the lab count as a zero. A lab is not completed until that lab is submitted for grading. Mere attendance is not sufficient. See the late penalties below on submitting work for grading. *More than one uncompleted lab results in a failing grade for the course!*

Make-up periods during weeks without scheduled labs may also be assigned as substitute days to perform labs missed due to unanticipated University closings, including snow days.

Late notebooks The teaching assistant will announce due dates for lab notebooks, typically two or three days after the lab is performed. A 2 point penalty will be applied to lab notebooks up to 1 week late. Beyond that, notebooks will be graded up to two weeks late, but with a 4 point penalty. *Labs more than two weeks late will not be accepted and are recorded as a zero, except with the permission of the coordinating instructor.* Any lab done in the make-up week at the end of the semester must be submitted by no later than the end of the final exam.

Repeating lab Students who are repeating PHYS 2014 must repeat all labs and take the final exam this semester. Previous work cannot be substituted. Students who are re-taking PHYS 2013 (lecture) but previously passed PHYS 2014 (lab) do *not* need to repeat PHYS 2014 unless required to do so by their major program requirements.

Individuals who have any disability, either permanent or temporary, which might affect their ability to perform in this class are encouraged to inform the faculty coordinator and lab section instructor at the start of the semester. Adaptation of methods, materials, or testing may be made as possible to provide for equitable participation. Please contact the Office of Disability Resources to discuss and arrange reasonable accommodations. (KSC 258, 218-726-6130, or visit the DR website at www.d.umn.edu/access for more information.)

Please be familiar with relevant campus academic policies linked below:
http://d.umn.edu/academic-affairs/academic-policies/classroom-policies/recommended-syllabi-policy-statements

This syllabus may be amended from time-to-time at the discretion of the coordinating instructor.

Laboratory notebooks

Notebook format requirements. Your performance in the lab is evaluated chiefly by the written records you keep. Think of your lab notebook as a diary or journal, i.e., a running record of your work, kept as it is done, not written mostly after the lab. It is *not* a highly polished final report, but it does need to contain enough detail to make it intelligible to another reader (and to yourself) after the fact. Entirely writing or re-copying large portions of notes and data collected during lab after the lab period is not acceptable.

- Leave the first page for use as a table of contents. Keep it up-to-date. Number all pages consecutively.
- Begin each experiment entry with a brief title statement of topic of the experiment. Date all entries. Give names of your lab partners at the beginning of each new lab.
- Initially write only on the right hand page; leave the left hand page for attaching graphs, extra calculations, after-thoughts, etc. **Write in pen.** If you make an error, simply cross it out. The crossing-out should not make the entry impossible to read; you might find the entry useful later. Don't make notes or calculations on loose sheets of paper unless specifically requested; put the information in the notebook immediately.
- The entries for each experiment may typically include:
  - simple sketch of the experiment that shows important components and quantities; description of any methods or procedures developed to perform the lab. Important equations relevant to the collection and analysis of data.

    A carefully drawn and labeled sketch can convey much about the experimental procedure and what was measured. Small, hastily drawn sketches are pointless. Sketches need not be great works of art to be informative, but they need to be carefully drawn. Someone not familiar with the experiment should be able to understand *in broad terms* what was done based only on your notebook.
  - data;
    Put data in tables whenever possible. **Always include units.** All data should be in the notebook. When data is collected by computer, printed tables should be taped – *not stapled* – into the notebook. If a computer-collected data table extends to many tens or hundreds of data points, *graphical* presentation of the data is preferred – *don't* include a very lengthy data table, but you must save and retain your own copy of the data file containing the data.
  - calculations;
    Show calculations in sufficient detail so another person can follow and check your work. Always begin a calculation by showing the formula being used, then substitute in numerical values *with units*, and finally give the final numerical result with units. The following example from the *Estimating Experimental Uncertainties* experiment illustrates the required format.

    $$\rho = \frac{4M}{\pi d^2 L} = \frac{4\,(52.3\,\mathrm{g})}{\pi(1.254\ \mathrm{cm})^2\,(5.12\ \mathrm{cm})} = 8.27\,\mathrm{g/cm^3}$$

    If a calculation is repeated several times, show one sample in detail and incorporate the results into an additional column in your data table.
  - graphs;
    When you include a computer-prepared graph or a separate sheet of paper, *tape* it into your notebook (no staples). Place it in a way that makes it easy for a reader (e.g. the grader!) to view it when reading your notebook. If printed in landscape mode, taped to a left hand page and folded in half, it will unfold for easy viewing. The characteristics of good graphs are discussed in an appendix of the lab manual. Don't stack several graphs on top of one another. Put them on separate pages with the appropriate notes about procedure, raw data, or records on the facing right-hand page. Turn to a new page in your notebook when starting a part of the experiment. **Don't** crowd your entries. There's plenty of space in the notebook.
  - a concise technical summary of results and answers to any end-of-lab questions assigned from the printed laboratory instructions.
- Lab notebooks must be initialed and dated by the instructor before you leave the lab.

Lab grading

All work required for the experiment must be kept in the laboratory notebook. A separately prepared lab report is not required. The day and time labs are due will be determined and announced by your lab instructor. The labs will be graded according to the following broad scheme. Not every experiment may involve every element indicated below.

Pre-lab exercise: 2 points

- Complete (i.e., including supporting work to answers) and largely correct pre-labs (only minor errors) earn 2 points
- Partially correct but serious attempts receive 1 point.
- Largely incorrect or incomplete attempts (often done at the last minute) receive a 0.

Documentation of Work Done – Experiment design and execution records: 5 points

Full credit for this will be based on the following expectations.

- Procedures *briefly* outlined, making use of diagrams to convey information compactly.
- Diagrams are meaningful: large, clear, labeled with important features and quantities; easily related to data recorded.
- Raw data recorded: organized in tables when possible, labeled, consistent use of significant figures and units.
- When raw data (especially large quantities) is presented graphically, the graph meets all expectations for a good graph (see below).
- The entries are reasonably well organized and are made during lab, not written mostly after lab.
- Lab work area is left with neatly organized equipment and clean of trash, ready for the next group.

Analysis – Making sense of the data obtained: 5 points

- Graphs: large, ranges appropriately chosen, axes labeled and units included, an informative title (beyond the axes labels), data points clear and easily seen. A lab manual appendix describes expectations in detail.
- Fits: results reported with appropriate number of significant figures and units.
- Calculations: start with formula, numbers plugged into formula, units displayed throughout, final result displayed with sensible number of significant figures. Sample calculation shown for repetitive calculations presented in tables. Computer-calculated quantities clearly explained - formulas presented in notebook in human-readable form, not computer-ese.
- Answers to questions posed in manual and assigned by instructor. Answers should be phrased to make clear what is being answered. One word answers without the correct context (e.g."Yes." or "2.12") are not acceptable. **Write a complete sentence** (or more, if needed).
- Error analysis: Estimates of experimental uncertainties are made as appropriate, and when requested propagation of errors applied to estimate uncertainties in final results.

Results and Technical Summary: 3 points

- Factual statement of results and correct physical interpretation of results.
- Quality of results reflects overall care taken in measurements and analysis.