

# Syllabus for Physics 0212

## Introduction to Laboratory Physics

### Spring 2016

#### Course and Instructor Information

CRNs	10142, 10188, 10145
Instructor	Russell Clark
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Office hours	Monday: 4:30pm – 5:30pm Tuesday: 8:00am – 9:00am Wednesday: 3:00pm – 4:00pm Thursday: 10:30am – 11:30am Friday: 7:00am – 8:00am Other times by appointment: <a href="http://tinyurl.com/Russell-Clark-Appointments">http://tinyurl.com/Russell-Clark-Appointments</a>

#### Course Description and Objectives

All sciences are a combination of theory (the hypothesis) and measurement (the experiment). A theory has no value unless it can be verified, or tested, by experiment. Once a theory passes this test, it may be expanded and tested further, which is the way that Physics and other sciences progress. So understanding experimental work is vital to understanding the process of science. A typical introductory physics course sequence, such as Physics 0110 and 0111, teaches the student the basic principles of Physics that were learned through the interplay of theory and experiment over several hundred years. Such courses focus on the theory side of Physics. In this course, you will learn how the experimental process works by learning how to obtain, analyze and present experimental results. You will also see the basic principles that you have learned in action, to see the physical reality behind the equations. Along the way you will learn to use the basic tools of experimental physics, from simple measuring devices such as a ruler, to sophisticated digital data acquisition systems. You will learn how physical theories are tested within the bounds of experimental uncertainties. By the end of the course you will have performed experiments and tested theories on the topics of mechanics, waves, energy conservation, fluid mechanics, electricity and magnetism, optics, spectroscopy and radiation.

The course is structured in two parts, a recitation and a lab with attendance required for both. The 50-minute recitation lecture will introduce the physical principles that are to be demonstrated by the experiments in the lab sessions. The lab sessions will include instruction on how to use the equipment and how to perform the experiment. The remainder of the lab will be used to collect and analyze the data.

#### Required Materials

The following materials are required for the course.

- 1) A lab manual titled, *Introduction to Laboratory Physics* by Russell J. Clark.
- 2) The *Student Lab Notebook with Spiral Binding* (50 Carbonless Duplicate Sets) by Hayden McNeil.
- 3) A scientific calculator that has trigonometric, logarithmic, exponential and statistical functions.
- 4) A USB flash drive (memory key).

## General Information for the Labs

- 1) **Eating and drinking are not permitted in the labs.** This is both for your safety and to prevent damage to the laboratory equipment.
- 2) **You are responsible for reading and understanding the section in the manual on the scheduled experiment before coming to the lab class.** Make sure that you understand the physical principles to be demonstrated and the general procedure for the experiment. The more prepared you are, the faster and easier the lab will go. Feel free to ask questions about the experiment at any time. A schedule of the experiments is listed below.
- 3) You will complete an online pre-lab quiz of 5 multiple choice questions before your lab session.
- 4) The lab teaching assistant (TA) will provide instructions on the experiment and the procedure. **Listen to this presentation very carefully** as the TA will explain exactly how to use the equipment and perform the experiment. Failure to follow the instructions could result in wasted time and damaged equipment. It could also pose a threat to your safety and the safety of those around you.
- 5) Before starting the experiment, make sure that you understand the function and purpose of the equipment. The lab manual should provide sufficient documentation for using the equipment, but if there is anything that you do not understand then ask your TA.
- 6) Students will work in groups of two with the following exceptions. If a class has an odd number of students, one group will have three people. If a piece of equipment fails and cannot be replaced, the members of that group will split up and join other groups. **Under no circumstances should a group have more than three students.**
- 7) Once the data is collected, you should analyze it before you leave the lab so that if you have any questions about the analysis you can ask your TA for help. Also, if you find some of your data is flawed or inconsistent you will have the opportunity to fix the problem and collect a new set of data.

## Lab Notebooks

Each student will keep a lab notebook, which is a vital practice for any scientist. The purpose of the notebook is to record all aspects of the experiment. If you are unsure if something is important then write it down anyway. Be neat, concise, clear and legible when writing in your notebook. Here are some guidelines for what to include:

- 1) Write down notes about the experimental procedure, possible sources of error, safety considerations, equipment status and any general observations you care to make. Include the title of the experiment, the date and the names of your TA and lab partners.
- 2) Record the conditions under which you performed the experiment. Some experiments require that you change the parameters each time that you collect data. Make sure you record those parameters before you start. For instance, in the lab on Oscillatory Motion you will record the period of a simple pendulum for five different lengths. You should record each length in your notebook before you begin taking the data.
- 3) Record your data. In some experiments you will record the data by hand just by writing down your measurements. Be neat and tabulate the data so that it is easy to read. Label the data and include physical units. Having a table of numbers is no good if you do not know what those numbers mean. In other cases a computer will collect and store large data sets. In actual research you would then record the file name and location of the file but here you only need to record the results of the analysis such as the slope and intercept from a linear fit to the data.
- 4) Record your mistakes. Scientists are human too, so you will sometimes make a mistake in the procedure or in setting up the experiment and you will record flawed data. Do not erase the data or delete it. Just make a

note of the mistake, fix the problem and record a new set of data. You should not include the flawed data in your analysis but you should still keep a record of it because you can often learn a lot from your mistakes.

- 5) **You will turn in the carbon copies of your lab notes at the end of the lab session.** These notes will be checked for organization, clarity and completeness. Also, the TA will verify that the data in your notes is the same data that you enter into the online lab reports.

## Lab Schedule

#	Date	Lab Title	Room
	1/4/2016	First Week	
1	1/11/2016	Ballistic Motion	402
	1/18/2016	MLK Observance	
2	1/25/2016	One Dimensional Motion	408
3	2/1/2016	Oscillatory Motion	402
4	2/8/2016	Fluid Mechanics	408
5	2/15/2016	Sound and Human Hearing	402
6	2/22/2016	DC Circuits 1	408
7	2/29/2016	DC Circuits 2	408
	3/7/2016	Spring Break	
8	3/14/2016	The Charge to Mass Ratio of the Electron	402
9	3/21/2016	Optics 1	408
10	3/28/2016	Optics 2	402
11	4/4/2016	Optical Spectroscopy and Atomic Structure	408
12	4/11/2016	Radiation and Radioactivity	402
	4/18/2016	Makeup Labs	

## Informal Lab Reports (LON-CAPA)

You will submit an informal lab report for each lab that you perform during the semester. These reports will be submitted online through the LON-CAPA system which may be accessed by this link:

<http://homework.phyast.pitt.edu/>

Your username for this system is the same as your Pitt email username and your initial password will be your PeopleSoft ID number (available through my.pitt.edu). Instructions on how to use this system to complete the lab reports will be provided by the instructor.

You must complete each report by the due date or you will not receive credit for that lab. Your TA will check the data that you enter into LON-CAPA to verify that it is the same data recorded in your lab notebook. The lowest informal lab report grade will be dropped.

Ten percent of each informal lab report grade will be for participation. This grade will be assigned by your TA based on your level of participation in the experiment and on the organization and completeness of your lab notebook.

## Formal Lab Reports

Scientists generally communicate the results of their experiments by submitting articles to peer reviewed journals. The journal editors send each article off to a group of peers (other experts in the field) who review it and determine if it is worth publishing. Generally the peers will return the article with comments and suggestions that the author (or authors) must address before it can be published. This iterative peer review system is what assures the integrity and quality of scientific papers.

In this class you will write one formal lab report which will be structured like a journal article. Instructions on how to write the formal lab report will be given in the lecture and sample reports are available online through Courseweb.

You will submit a first and second draft of your formal lab report to an online peer review system. The first draft will be evaluated by several anonymous peers (other students in this course). In turn, you will anonymously review several first draft reports of your peers and provide feedback to them. You will be given more specific information on how to use this online peer review system at a later time. The second draft of the report will also be submitted to the peer review system, but it will only be graded by a TA.

You may write your formal lab report on any lab that you have completed prior to the due date for the first draft (see the schedule below). Each lab generally has several different sections each with a different experiment that pertains to the overall topic of the lab. Your formal report must cover all of the sections within the lab that you choose.

## Formal Lab Report Schedule

**The due dates are strict and late reports or reviews will incur a severe penalty.**

First Draft	First Draft Reviews	Second Draft	Back Reviews
3-18	4-1	4-15	4-15

Each student is required to write her or his own lab report. Lab partners will obviously share data and plots, but **group reports are not allowed.**

**Please note that all formal lab reports will be submitted to [turnitin.com](http://turnitin.com) to check for plagiarism.**

## Lecture Questions and Attendance

The recitation lecture will utilize the Student Interactive Response System (SRS) to take attendance. This system consists of hand-held remote controls, called pads or clickers, assigned to individual students. These pads will be used to take attendance during each lecture and to answer multiple choice feedback questions. The feedback questions do not count towards your grade.

The pads will be stored in bins on a cart at the front of the room so that you may pick up your pad before lecture and then place it back there at the end of lecture. **Do not take the pads out of the classroom!** Many other classes use the same system and pads. If your pad is missing then notify your instructor.

## Grades

The lowest informal report and quiz grades will be dropped. **Makeup labs, quizzes and exams will be given at the discretion of the lecture instructor.** The grades are weighted according to the table below.

Recitation Attendance	5%
Pre-Lab Quiz	10%
Formal Lab Report 1 <sup>st</sup> Draft	2%
Formal Lab Report 2 <sup>nd</sup> Draft	5%
Formal Lab Report Review Tasks	3%
Informal Lab Report	60%
Final Exam	15%

## Grade Change Policy

Grade cutoffs are chosen to be as fair as possible but ultimately the line has to be drawn somewhere and it has to be drawn straight. Extra credit opportunities may be offered to the class as a whole but not to individual students. Once your final grade for the semester has been submitted to the Registrar it will not be changed unless there is a verifiable error in the grade book, such as a missing grade or a grade that was entered incorrectly. You can check all of your course grades at any time on Courseweb (<http://Courseweb.pitt.edu/>).

## Makeup Labs

Makeup labs are only given at the discretion of the instructor. The lowest informal lab report and quiz grades are automatically dropped, so if you miss a lab for any reason then that will be the lab that is dropped and no makeup will be allowed. If you miss two labs during the semester and you have a valid reason for missing both, then you will be allowed to makeup one of the missed labs; the other lab will be dropped. Valid reasons include illness (a doctor's note may be required), family emergency, or other events of similar importance.

## Academic Integrity

All students are expected to adhere to the standards of academic honesty. Any student engaged in cheating, plagiarism, or other acts of academic dishonesty would be subject to disciplinary action. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity (<http://www.provost.pitt.edu/info/acguidelinespdf.pdf>). This may include, but is not limited to the confiscation of the examination of any individual suspected of violating the University Policy.

## **Courseweb**

The University of Pittsburgh provides an online portal for participating classes called Courseweb and a site has been created for this course. Here you will find relevant course material such as a copy of the syllabus, sample exams, etc. You may also view your grades online through this site.

<http://courseweb.pitt.edu>

The username and password is the same as your Pitt email account. If you need to setup your email account or have forgotten your username and password then call the computer center help desk (4-HELP or 412-624-4357).

## **Disability Services**

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services, 216 William Pitt Union, (412) 648-7890/(412) 383-7355 (ITY), as early as possible in the term, DRS will verify your disability and determine reasonable accommodations for this course.

## **Statement on Classroom Recording**

To ensure the free and open discussion of ideas, students may not record classroom lectures, discussion and/or activities without the advance written permission of the instructor, and any such recording properly approved in advance can be used solely for the student's own private use.

## Scientific Writing in the Formal Lab Reports

Scientists generally communicate the results of their experiments by submitting an article to a peer reviewed journal and the journal editor sends the article off to a group of peers (experts in the field) who review it. Generally the peers will return the article with comments and suggestions the author (or authors) must address before it can be published. This iterative peer review process is what assures the integrity and quality of scientific papers. In this class you will write one formal lab report which will be structured like a journal article. Sample reports are available online through Courseweb.

The purpose of an experiment is to test a theory. When you write your formal lab report, focus on showing the reader how your experimental results support the theory (which should always be the case in this class). Assume your audience has a general background in physics (has completed an introductory physics course) but is not in this lab course. In other words, don't think of your audience as being your lab partner or your TA, keep it general.

Remember that a lengthy report is not necessarily a good report. Good writing in science, as in anything else, is determined by how well the author can convey the ideas to the reader. If your report reads like a laundry list, a cook book or the fine print in a legal document then it will likely receive a low score from your TA and from your peers. Write the kind of report that you could read and understand. Also remember that your job is not to recreate the lab manual but rather to present the experiment and the results to the reader in your own words.

### Sections

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- 1) **Abstract** - This is a one short paragraph summary of the experiment including your final results (measured values). The title of a paper can only convey a limited amount of information and is generally not enough for a reader to decide whether or not he or she wishes to read the whole thing or not. The purpose of the abstract therefore is to give the reader a quick summary of your paper so he or she can decide whether or not to invest the time in reading the entire article.
- 2) **Introduction and Theory** - Here you should describe the basic physical theory behind the experiment and how the experiment tests the theory. Include all the relevant formulas and how they are used. **WRITE IN YOUR OWN WORDS; DO NOT COPY TEXT FROM THE LAB MANUAL.** You are allowed to use figures and equations from the lab manual provided you cite it as a reference. You do not have to derive each equation from scratch or show each and every step in the derivation, but you should provide enough information so that the reader can work it out on their own.
- 3) **Experimental Setup** - Explain the experimental procedure and how the data was collected. Your report should include enough information that anyone reading it could, in principle, reproduce your experiment. Describe the equipment and the experimental procedure in detail but don't write out each and every step of the procedure cook book style. Many of the individual steps in the procedure are specific to the equipment you used and a general reader may not have exactly the same equipment or software. Plus, it just isn't very interesting for the reader to wade through step by step instructions of an experiment that is not sitting right in front of them. If necessary, include labeled diagrams of the equipment. You may copy figures from the manual with a citation, but **DO NOT COPY THE WRITTEN MATERIAL.**

- 4) **Data Analysis** - Include your data in tables with labels and captions. Likewise, show the results of your analysis in tables and plots with labels and captions. You do not need to show each and every calculation, but provide enough information for the reader to follow what you did. Don't make the reader guess how you arrived at a calculated value. The results of your analysis should support your conclusions in the next section.
- 5) **Conclusion** – Like the abstract, the conclusion should be a summary of the whole experiment but it should focus on the final results and sources of uncertainty. The conclusion may be longer than one paragraph. Include your own observations and comments regarding the experiment and suggest ways to improve the results. Explain how your results support the theory. If they do not support the theory, then explain why not. Do not simply ascribe discrepancies to “experimental error” or “equipment failure.” Be specific about the source of the error or what exactly failed and estimate the magnitude of the error on the final result.
- 6) **References** – Provide a citation for any material that you have included from external sources. This includes the lab manual and the instructor's lecture notes.



## Formal Lab Report General Points

- **You may write your formal lab report on any lab that you have completed prior to the due date for the first draft.**
- **You must write the report on all of the experiments in that lab.** Each lab generally has several different sections each with a different experiment that pertains to the overall topic of the lab. Your formal report must cover all of the sections within the lab that you choose.
- **No particular text style or citation style is required.** Just use whatever style that you are comfortable using.
- **It is best to use a passive voice.** For example, instead of saying, “I performed this experiment,” you should write, “An experiment was performed.”
- **Don’t let your report suffer from TMI (too much information).** There is no word count requirement and there is no prize for having the longest report.
  - Generally students think of writing in terms of liability: If you throw in every detail that you can possibly think of then the grader cannot take off any points. Actually, a short, well written report will receive a higher grade than a report that simply restates everything in the lab manual.
- **Your audience should be a student, like yourself, who has taken an introductory physics course but not this lab.** Your audience is not your TA or instructor. Describe the experiment and explain the theory and procedure the way you would want someone to explain it to you.
- **Describe the experimental setup, the theory and the procedure in a general way.** In principle the reader should be able to reproduce the experiment and your results, but you do not need to provide highly detailed information like a list of every piece of equipment or a step by step list of the procedure.
- **The abstract should be one short paragraph which summarizes everything in the report.** The purpose of an abstract is to give someone a chance to see a snapshot of your report and then decide if she or he wishes to read the whole thing.
- **You may include figures and equations from other sources (such as the lab manual) but always include a reference to that source.**
- **Describe the experiment in your own words.** Plagiarism will not be tolerated, so don’t be tempted to cut and paste from the lab manual or use a report written by another student (even if you only intend to use it as a template). Lab partners must submit different, individual reports.

## Pre-Lab Quizzes on LON-CAPA

- The quiz will consist of 5 multiple choice questions for the upcoming lab.
- The quiz will be due by 11:59pm the Sunday before the lab.
- There are sample quizzes on Courseweb.
- Each quiz will become available one week before it is due. You may start the quiz anytime during that week.
- Once you start the quiz, you will have **20 minutes** to complete it. Note that the timer keeps going even if you navigate to a different page, log off or lose internet connection. Make sure that you have a stable internet connection before starting the quiz.
- Make sure that you start the quiz at least 20 minutes before the due date so that you have time to complete it before the due date.
- Click on the first question in the quiz. **This will NOT start the timer.**
- Click on “Show Resource”. **This will NOT start the timer.**
- A popup window will appear which says “Start Timer?” **The timer will start once you click “OK”.**
- Choose the best answer for the question and then click “Submit Answer”.
- You have 3 tries for each question.
- No feedback will be given whether the answer that you submitted is correct or incorrect.
- You will receive full credit (1 point) if the final answer that you submit is correct. Multiple tries do not lower your grade. You will receive a zero for the question if the final answer that you submit is incorrect.
- When you finish a question, move on to the next.
- When you finish the last (fifth) question, the system will automatically take you to the next quiz. However, this quiz will not start unless you click “Show Resource” and “OK” for the “Start Timer?” popup. So as long as you are not click happy, you don’t have to worry about accidentally starting the next quiz.

## Informal Lab Reports on LON-CAPA

- You will start by entering the data from your experiment. Please note that your TA will check to make sure that the data that you enter matches with your lab notes.
- **Give yourself plenty of time to complete the lab report.** If you start on the report early then you can contact your instructor or your TA for help if you encounter a problem, but if you wait until last minute then you will not have time to get help.
- Put a space between the numerical value and the units, like this: “1.0 m”.
- When entering scientific notation:
  - Enter it like this: **1.00e-5** and NOT like this:  $1.00 \times 10^{-5}$ .
  - Do not put a space between the number and the “e”, so “1.00e-5” NOT “1.00 e-5”.
- Do not enter commas in numbers, such as 7,000 (enter this as 7000 or 7.0e3). The comma will be treated as a decimal point.
- Generally you will have to enter multiple data points at the same time. The system will not accept any of the data points until they are all within the acceptable range. So if one data point in the set is out of range then the whole set will be rejected. If this happens then check each point carefully. A “hint” will appear with the acceptable range for each value to make it easier to check your data.
- **Carefully check your data before you hit Submit Answer.** When you enter your data, you will be given one chance (and only one chance) to check the data and re-enter it if necessary. If you enter the wrong data twice, then you will have to contact your TA to reset that whole section of the report.
- After you enter your data you will be given analysis questions based on that data.
- Use a spreadsheet program such as Excel to do the calculations before you try to enter the values into LON-CAPA. Excel is much easier and faster than using your calculator. Also, it is easier to make changes if you find a mistake in your calculations.
- Do not round numbers when carrying out calculations. NOTE: When you enter the correct answer for one of the analysis questions, LON-CAPA will display the numerical answer, but it will be rounded. **Do not use this rounded value for other calculations! Use your original value.**
- When you complete the informal lab report, the parts that you have finished will be marked with a green check (see the next page). However, parts labeled "reenter" or "check" may still be marked with a yellow arrow indicating that those parts are incomplete. In the example below, part "reenter-block3A" is marked as incomplete. The "reenter" and "check" parts do not count towards your grade (they are worth zero points) and so it is okay if they are incomplete. These parts are only used by LON-CAPA when you need to re-enter your data if it is incorrect on the first try.

<a href="#">?</a> <a href="#">PHYS 0212 - Ballistic Motion - Section 2-4 - Small Ball problem</a>	
<a href="#">(Part: block3A)</a>	<input checked="" type="checkbox"/>
<a href="#">(Part: check-block3A)</a>	<input checked="" type="checkbox"/>
<a href="#">(Part: reenter-block3A)</a>	→ Due this Sunday, Jun 26 at 11:59 pm (EDT)
<a href="#">(Part: block3B)</a>	<input checked="" type="checkbox"/>
<a href="#">(Part: block3C-small-R)</a>	<input checked="" type="checkbox"/>
<a href="#">(Part: block3C-small-h1)</a>	<input checked="" type="checkbox"/>
<a href="#">(Part: block3C-small-mean)</a>	<input checked="" type="checkbox"/>
<a href="#">(Part: block3C-small-std)</a>	<input checked="" type="checkbox"/>
<a href="#">(Part: block3C-small-v0)</a>	<input checked="" type="checkbox"/>
<a href="#">(Part: block3C-small-v0-p)</a>	<input checked="" type="checkbox"/>
<a href="#">(Part: block3C-small-v0-m)</a>	<input checked="" type="checkbox"/>
<a href="#">(Part: block3C-small-UNC)</a>	<input checked="" type="checkbox"/>
<a href="#">(Part: block3C-small-ratio)</a>	<input checked="" type="checkbox"/>

In the example below, notice that the check sum is the sum of the values in the first column of the table (Distance from Plumb Bob Without the offset). When you sum the values in your lab notebook then it should be exactly equal to the check sum. If the two sums are different then you know that the data entered into LON-CAPA is different than the data in your notebook and so you will need to correct it.

**PHYS 0212 - Ballistic Motion - Section 2.4 - Large Ball**

Due never

You entered the following values:  
 $\theta = 34.5$  deg  
 $h' = 0.203$  m  
 Offset = 0.012 m  
 $h_2 = 0.365$  m  
 Large Ball Diameter  $D = 0.02$  m  
 Large Ball Mass  $m = 0.028$  kg

Data	Distance from Plumb Bob Without the offset (units "m")	Impact Distance / With the offset (units "m")
1	0.424 m	This will open later.
2	0.416 m	This will open later.
3	0.421 m	This will open later.
4	0.407 m	This will open later.
5	0.421 m	This will open later.
6	0.42 m	This will open later.
7	0.426 m	This will open later.
8	0.426 m	This will open later.
9	0.418 m	This will open later.
10	0.423 m	This will open later.

**Distance check sum = 4.202 m**  
**Are these values correct?**  
 Yes  
 No

0 Points

Submit Answer Tries 0