

# PHYSICS 274L — GENERAL PHYSICS III LAB

UH MANOA — Fall Semester 2011

## Course Information & Policies

Lab Meetings           Thursdays 1:30–4:20 p.m., in Watanabe Hall, Rm. 419

Instructor             Shigenobu Matsuno

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(please avoid mailing to [matsunos@hawaii.edu](mailto:matsunos@hawaii.edu))

Office: Watanabe Hall, Rm. 331, (808) 956-2966

Hours: Mon. Fri. 1:30–3:00 p.m., or other times by appointment

(*Note:* It is a good idea to call or e-mail first, if you plan to stop by.)

T.A.                     Kevin Croker

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Office: Watanabe Hall, Rm. 430, (808) 956-2937

Hours: *To Be Announced*, or at other times by appointment

### Required Materials

- **notebook/binder** for recording measurements & observations
- **scientific calculator** with scientific (power-of-10) notation, trig functions, exponents and logarithms, but NO graphing necessary. (Good idea to bring to lab sessions, but not mandatory.)

Optional Books       your PHYS 274 textbook, or equivalent

Taylor, John R., *An Introduction to Error Analysis*, 2<sup>nd</sup> ed. (1997)

paperback: ISBN 0-935702-75-X (UH Bookstore: \$44.50 new, \$33.85 used)

### Course Description

This course is intended to supplement the material of PHYS 274 (geometric and wave optics, special relativity, atomic and nuclear physics) by illustrating some of its concepts with hands-on experiments.

*Prerequisites:* PHYS 152L or 272L; and PHYS 274 (or concurrent). Note that this also implies satisfactory completion of PHYS 151, 151L, and 152; or of PHYS 170, 170L, and 272. Note also that MATH 243 or 253A (3<sup>rd</sup> semester calculus) is a pre- or co-requisite for PHYS 274, and hence for this lab. While little calculus is required to understand the theory or to perform our experiments in 274L, you will regularly need to compute partial derivatives when performing error analysis. A grade of “C” or better is considered satisfactory completion of any prerequisite.

This one-credit course also satisfies a Writing-Intensive focus requirement.

### Experiments

The PHYS 274L lab currently houses eight working experiments, of which you must complete **SEVEN** during the semester. The experiments are as follows, with the **six required experiments in boldface**. You may then choose either of #8 or #9:

- 1. One- and Two-Slit Diffraction**   *Matsuno*
- 2. Bragg Diffraction**               *Croker*   *lab partner recommended*
- 3. Michelson Interferometer**       *Croker*   *lab partner recommended*
- 4. Photoelectric Effect**           *Matsuno*
- 5. Electron Diffraction**           *Matsuno*   *prerequisite: Exp. #2 Bragg Diffraction*
- 6. Hall Effect in p-type Ge**         *Croker*

- (7. Franck-Hertz Experiment —out of order)
8. Atomic Spectra *Matsuno*
9. Band Gap of Germanium *Croker lab partner recommended*

If you are currently enrolled in PHYS 274 lecture:

We suggest that you sign up to complete the experiments **roughly in the order above**, since it approximates the order that the topics will be covered in lecture. For example, wave optics/interference is the first topic in PHYS 274 lecture, and it is the subject of our Experiments #1–3. Likewise, we suggest that you save Exp. #8 (Atomic Spectra), which deals with atomic structure and the quantum phenomenon of spin-orbit coupling, for last. Exception: Exp. #6 (Hall Effect) uses only concepts from PHYS 272 (electromagnetism), so it can be performed at any time.

If you have already taken PHYS 274 lecture:

You may sign up to complete your experiments **in any order**. Exception: everyone should complete #2 (Bragg Diffraction) before attempting #5 (Electron Diffraction).

You can sign up for experiments several weeks in advance, and you may add, change, or cancel your scheduled experiments anytime that lab is open. You may also contact your instructor or TA for help with sign-ups whenever lab is closed. Your instructor will e-mail weekly reminders of who is scheduled for each experiment.

You will have approximately 14 weeks to complete seven experiments, which averages to **approximately one experiment every two weeks**. You may pace yourself accordingly when signing up for future experiments, although you are free to work faster if you wish. If you are not scheduled to perform an experiment on a particular Thursday, you do NOT need to attend lab on that day.

You may sign up **either alone or with ONE partner**. The partner does not need to be the same person for each experiment, but may be if you wish. (See section on “Collaboration” below for more information on working with a lab partner.) “Trios” may occasionally be approved for certain experiments, depending on the number of students enrolled in the lab.

### Oral Quizzes

You are required to take an oral quiz on the theory and objectives of each experiment before you begin taking data on that experiment. The oral quiz will be with your instructor or TA, will last 10 to 15 minutes, and will consist of:

- (1) your instructor posing questions to you about the physics and theory of the phenomenon to be studied; and
- (2) your instructor introducing and orienting you to the apparatus to be used.

Your quiz will be scored on a scale of 0 to 10 points.

If your oral quiz score is 5 points or lower, you will be asked to re-study the lab writeup and theory, and to reschedule your data-taking for a later date with a new oral quiz. Specific deficiencies in your preparation will be pointed out for you to remedy before your next attempt.

### Lab Notebooks & Data-Taking

You are encouraged to keep a lab notebook for making pre-lab study notes, recording data while in lab, making quick calculations, and noting any other observations that might prove useful while writing your lab report. However, you are NOT required to submit your notebook at any time for evaluation.

You are also encouraged to calculate a rough result or to make a quick-look graph of your data *in lab before leaving*, to “sanity-check” your results. If you discover a problem in your data, it can be remedied by taking fresh data the same day before you leave. You may use the 274L lab computers, use the computers upstairs in Watanabe 421, or bring your own laptop (both “uh” wireless and Ethernet-cable Internet connections are available in lab).

See section on “Collaboration” below for more information on taking data with a lab partner.

### Lab Reports

We recommend that you commence work on your lab report *promptly* after taking your data for that particular experiment — the sooner you begin your writing, the better you will remember the details of your data and the circumstances of your observations.

Lab reports typically contain **between three and 10 pages of double-spaced type**, depending strongly on the particular experiment, and must be sufficient (in total) to satisfy the Writing-Intensive focus of this course. Each lab report will be scored on a scale of 100 points according to a predetermined rubric (to be distributed separately). Although most details will be left up to you, all reports should follow a basic structure and writing style similar to that of a **short scientific paper**:

Abstract, Introduction, Theory, Procedure, Raw Data, Calculations/Results, Discussion, Conclusion, and References

One of our aims is to help you develop and improve your scientific writing. While tidy formatting and basic organization are relevant to this goal, your reports need not be flawless models of desktop publishing. Please **type** your lab reports using any standard word processor that can produce simple mathematical expressions and Greek letters, but very complex formulas or lengthy calculations may be written by hand. Graphs may be prepared using any graphing application that you are most familiar with: our computers in 274L lab have Graph, Graphical Analysis (both used in PHYS 170L & 272L), Excel, and GnuPlot installed. Many of our experiments require least-squares linear fits *including uncertainties*; see your instructor for how to do this when the time comes to prepare your first graphs.

You have the option to **revise and resubmit** the FIRST TWO of your lab reports for better scores, if you wish: the draft should first be submitted either to your instructor or TA. Your revisions should directly address the comments provided by them, and your revised report must be resubmitted with the old report (and score sheet) attached. Please discuss this with your instructor or TA individually if you would like to exercise this option; revised reports will usually be due one week after the graded reports are returned to you.

More recommendations on the style and format of lab reports will be provided in a separate handout.

### Due Dates

The **due date** for any lab report is **two weeks after you take your data**. After that date, reports will be **penalized by –10% for each additional week** that they are late. Labs should be submitted to the person in charge of that particular experiment (see list above): either your instructor (or slid under his office door) or TA (or slid under his door). You should contact either of them in advance of the due date if you discover problems with your data or analysis, or if you have questions about your writing.

You may submit a report electronically as an e-mail attachment. In this case, you should submit a report only in PDF format and you are responsible to confirm successful submission of the report.

**One-week extensions** may be requested if substantial progress on your report is completed (and shown to either your instructor or TA) by the regular due date.

## Grading

Each of your seven lab reports will be worth 100 points and each oral quiz 10 points. Additional homework assignments (for example, 30 points for Error Analysis homework) will also be a small part of your point total. Your **overall course percentage** will be computed as a simple fraction of your total points earned divided by the total points possible.

Your final grade will be based on your **overall course percentage**. An overall percentage of 90% will guarantee you at least a final grade of A; 80% at least a B; 70% at least a C; and so forth. In the final determination of grades, these cutoffs may be lowered at the discretion of the instructor.

## Collaboration

In this lab, you are welcome to conduct experiments and to take data **with a partner**. (Indeed, for Experiments #2, #3, and #9, working with a partner makes data-taking *much* easier.) Working in pairs or groups is common in science labs, and indeed is encouraged: teamwork can help you to make measurements and catch errors faster, and explaining something to another person is a great way to learn it yourself.

However, if you are “working with” a classmate while making a measurement, there are a few guidelines to follow:

- (1) You should take turns occasionally and each ***make some of the measurements yourself***, so that each of you gets the educational value and experience of using the equipment and “seeing for yourself.”
- (2) All final lab reports should be written by you ***in your own words***, even if the raw measurements or data you are using are identical to your partner’s. If you do perform the experiment with a lab partner, ***make a note in your lab report*** of the name of your partner for that particular experiment.

In the end, your submitted work should reflect ***your own understanding***. Any passages or calculations that are simply copied or plagiarized from another student, or from any other uncited source, will be given **no credit**. Serious cases of plagiarism may be referred to the Dean of Students for disciplinary review.

## Lab Conduct & Safety

Our experiments use a few lasers, a microwave transmitter, some high voltages, and some exposed circuitry. While they are generally low power, fairly safe, and have a good deal of protection, they are NOT completely harmless! Your instructor or TA will review **relevant safety tips** during your Oral Quiz for each experiment.

If any **equipment breaks or fails** during your experiment, please inform your instructor or TA; do NOT leave it to be discovered as a rude surprise by the next person who tries to use it. We have only one apparatus for each experiment, so non-working equipment must be fixed promptly.

Food is generally NOT allowed in lab, and beverages are permissible, but should be kept far from experimental apparatus and computers. Any trash including beverage containers should be properly disposed of, however **DON'T** put perishables into trash bins in the lab.

## Lab Web Page

Web page of Phys274L, <http://www.phys.hawaii.edu/~phys274l>, has been created to aid students taking this course. Information regarding the course, along with additional ones including that of error analysis, data plotting softwares, word processing softwares, etc., can be found there. You have to use this page to sign up an experiment by yourself, also.