

Physics 196 The Cosmic Universe Lab
Gustavus Adolphus College Fall 2017

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Lab Manual: PHY196 Lab Manual - Fall 2017

Course Objectives

1. Exploration of physical laws relating to mechanics, optics, thermodynamics, and astrophysics
2. Exposure to modern laboratory techniques
3. Introduction to data analysis and uncertainties
4. Familiarization with the Vernier *LabPro* interface and *Logger Pro* software for computerized data acquisition and analysis
5. Familiarization with *SigmaPlot* software and *Modelfit* plug-in for graphical analysis and least-squares fitting
6. Development of writing skills for the preparation of laboratory reports

Course Policy and Evaluation

1. **Lab Materials:** Students should bring the lab manual and a calculator to each lab period.
2. **Lab Attendance:** Regular attendance at all labs is required. Students will be held responsible for informing themselves of all announcements and assignments made in the laboratory classroom as well as in the daily PHY195 class meetings. Any last minute communications will be by email. Each student will register for one lab section. Students must arrange with the instructor in advance to attend another lab section or to schedule another time to perform the lab; they may do so only for a valid health or school-related reason.
3. **Pre-Lab Quizzes:** Students are expected to be thoroughly familiar with the purpose and general procedures of the experiment **before** coming to lab. Advance preparation is an absolute requirement for the efficient use of the limited lab time. A pre-lab quiz will be given each week either in class or via the WebAssign program (<https://webassign.net>). The due date/time for the student's quiz responses will be 15 minutes before lab class begins each Wednesday (or Thursday).
4. **Lab Groups:** Students will work in groups of two (or three). It is essential that **ALL** members of the group are completely familiar with the measurements and the data analysis.
5. **Work Performed During the Laboratory Period**
 - a. Class Discussion: At the beginning of each lab period, your instructor will lead a class discussion of the Warm Ups and Predictions sections of each problem.

- b. Lab Group Discussion and Solution Plan: Once it appears that the class understands the warm ups and predictions, each assigned lab group will enter into a small group discussion to plan their solution to the assigned problem. The result of this discussion will be the creation (on the computer word processor) of a group solution and measurement plan as the first section in a Lab Procedure and Analysis document.
- c. Measurements and Recording of Procedures: Once your instructor has approved your measurement/solution plan, your group will take the necessary measurements. In that process, if your procedure deviates from your original plan, explain the needed changes in your Lab Procedure and Analysis document.
- d. Data and Data Tables: In the process of making and analyzing measurements, you will generate data tables and graphs, including perhaps fitting of your data to mathematical models. Print out a copy of each data table or graph and staple it to your Lab Procedure and Analysis document before submitting everything at the end of the lab period.
- e. Data Analysis and Results: Once the measurements are complete, analyze your data and document the analysis in your Lab Procedure and Analysis document. A copy of the completed Lab Procedure and Analysis document, with data tables/graphs attached, must be handed in **before you leave the lab**. Your group will receive a single (shared) grade for the Lab Procedure and Analysis document. You should also save a copy of that document so that each member of your group can attach a copy to their one-page Problem Summary report.

6. Lab Reports:

- a. At the end of every lab each student will be assigned to write up a summary of one of the experimental problems. Your Problem Summary must present a clear and accurate account of what you and your group members did, the results you obtained, and what the results mean. A Problem Summary must not be copied or fabricated. (That would be scientific fraud.) Copied or fabricated problem summaries will be treated in the same manner as cheating on a test. Your Problem Summary should describe your experiences, your observations, your measurements, and your conclusions. A description of the Problem Summary format is given in the Lab Manual.
- b. A lab report, including:
 - (1) a Cover Sheet (blank copies will be provided in lab, see sample below);
 - (2) a copy of your group's Lab Procedure and Analysis document; and
 - (3) your One-Page Problem Summarystapled together in that order, is due within two class days of the end of that lab. (Wednesday lab reports are due on Friday; Thursday lab reports are due the following Monday.) *There will be a one-half-point-per-day penalty for summaries.*

7. Evaluation:

There are three parts of your grade for each laboratory: (a) your online WebAssign pre-lab score; (b) your group's Lab Procedure and Analysis document; and (c) your One-Page Problem Summary. Your Lab Procedure and Analysis document and Problem Summary will be graded and returned to you at your next lab session.

8. Grades:

| | | | | | |
|-----------------------------|------|----|----------|----|---------|
| Lab Reports | 100% | A | 94 - 100 | C+ | 74 - 78 |
| (Including Pre-Lab Quizzes) | | A- | 90 - 94 | C | 70 - 74 |
| Observing Labs Included | | B+ | 86 - 90 | C- | 66 - 70 |
| | | B | 82 - 86 | D+ | 62 - 66 |
| | | B- | 78 - 82 | D | 58 - 62 |

9. **Incompletes:** A grade of incomplete will be given only for work not completed due to circumstances beyond the control of the student.

Laboratory Schedule**Experiment**

Modeling Reality
 Kinematics in One Dimension
 Kinematics in Two Dimensions
 Newton's Second Law
NO LAB – Nobel Conference
 Reflection and Refraction
 Lenses
 Interference and Diffraction
 Spectroscopy
 Radioactivity
 The Greenhouse Effect
NO LAB – Thanksgiving
 HR Diagram of Star Clusters
 Hubble's Law

Dates

September 6, 7
 September 13, 14
 September 20, 21
 September 27, 28
October 4, 5
 October 11, 12
 October 18, 19
 October 25, 26
 November 1, 2
 November 8, 9
 November 15, 16
November 22, 23
 November 29, 30
 December 6, 7

Observing Labs

Observing the Night Sky
 Observing Project

DUE October 20
DUE December 12

PHY196 LABORATORY REPORT SAMPLE COVER SHEET

Laboratory Number and Title _____

Name _____

Date performed: _____ Day/Time section meets: _____

Lab Partners' Names: _____

Problem # and Title: _____

Lab Instructor's Initials: _____

| Grading Checklist | | | Maximum | Points |
|---|--------------------|--|------------|--------|
| WebAssign PRE-LAB QUIZ: | _____ out of _____ | | 20 | |
| LAB PROCEDURE and ANALYSIS (GROUP GRADE): (measurement plan/procedure recorded, printed out and handed in before the end of lab period, along with copies of tables and graphs made as data were collected, along with data analysis) | | | 50 | |
| SOLUTION PLAN and MEASUREMENT PROCEDURE (plan clearly stated before beginning measurements; procedure modified and documented as needed) | | | | |
| DATA TABLES and/or GRAPHS (must be attached) (clear and readable; units and assigned uncertainties clearly stated) | | | | |
| DATA ANALYSIS and RESULTS (results clearly indicated; correct, logical, and well-organized calculations with uncertainties indicated; scales, labels and uncertainties on graphs; physics stated correctly) | | | | |
| ONE-PAGE PROBLEM SUMMARY: | | | 30 | |
| ORGANIZATION (clear and readable; logical progression from problem statement through conclusions; refer to lab procedure and analysis where necessary; correct grammar and spelling; section headings provided; physics stated correctly) | | | | |
| CONCLUSIONS (comparison to prediction & theory discussed with physics stated correctly ; possible sources of uncertainties identified; attention called to experimental problems) | | | | |
| TOTAL | | | 100 | |