

**General Physics I Laboratory**  
**PHY-121 Fall 2021**  
**Gustavus Adolphus College**

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**Course Objectives**

- Explore physical laws applicable to kinematics, dynamics, oscillations, waves, thermodynamics, and fluid dynamics.
- Learn to formulate and test qualitative and quantitative hypotheses for physical systems
- Acquire experience and skills in making measurements and collecting data
- Acquire experience and skills in analyzing and reporting experimental data
- Learn to apply basic error analysis and error propagation techniques

**Course Policies and Evaluation**

**Lab Materials:**

- PHY-121 General Physics I Laboratory Manual available at the Book Mark
- Two laboratory notebooks (5 x 5 quad ruled; Ampad, Roaring Spring, or equivalent brand recommended)
- A calculator
- A flat straight edge or ruler for making charts and tables (optional)

**Pre-Lab Exercises:** All experiments in the lab manual are accompanied by a Pre-Lab exercise. The Pre-Labs will be in the form of a Moodle assignment. Moodle assignments are due (must be completed and submitted) **30 minutes prior to the start lab each week**. Late submissions are not accepted by the Moodle server.

**Lab Notebooks and Reporting:**

An objective statement, theory to be used, and roadmap of the procedure **should be prepared in advance** and recorded in your notebook:

Lab objective

- A sentence stating the purpose of the lab to be performed.

Summary of physics principles (theory)

- A few sentences describing (in your own words) the principle of physics you are investigating.

Roadmap of observation methods

- A few sentences describing what measurement or observation methods/equipment you plan to use in your investigation and how the data will be used to test the physics principles. This will ***not*** be step by step and may change when you actually begin the measurements.

In the laboratory, the lab notebook becomes a sequential journal of data collection procedure, observations, calculations, and any analysis that is done. In it you will record everything of significance that you do and observe. What does this mean? While it may be appropriate to record the fact that your lab partner sneezed if you were preparing a culture in a biology lab, it probably does not matter in the physics lab, unless it results in the equipment being knocked over. You will need to decide what is significant. And we will help you with that, particularly early in the semester when the instructor and lab assistants will make frequent checks of what you are recording in your notebook.

The in-lab journal component answers two questions:

What data did you collect?

- Data that is collected by hand should be recorded by hand and sufficiently annotated to be understood.
  - Numbers need to have units and short descriptive phrases that act as labels.
  - Sets of data are organized into tables with columns labeled and with units.
  - Uncertainty estimates should be given for all measurements.
- Data (charts and tables) that are collected via computer can be taped into the notebook. Again, descriptive information and units are essential. Data should be saved for future analysis and the location and filename recorded in your notebook.
- Often observations are not simply a number and need to be represented qualitatively by a short piece of descriptive prose.

How did you collect it?

- Record the procedure step by step as you do it.
- Sketches are essential in conveying procedural information. **Make a sketch of everything that is important.**
- Procedure and data may be intermixed. It is most appropriate to record the procedure, then the data, or vice versa, as long as it is clear.
- Data and procedure for each section should be kept together. If any calculations are done during the lab, they should be with the data and procedure. The same is true of any graphs you create as you are doing the lab.
- Deviations should be discussed. For example, equipment malfunctions, mishaps, or procedural stumbles.

The lab notebook also serves as a container for analysis, results, and answers to questions that come after the laboratory session is completed. This material should be entered in hand written form. In most cases, you will need to perform some calculations using the data you collected, make graphs, and fit the data to a model to test a particular theory. You will record this in a step by step manner in your notebook, just as you did the procedure and data in lab. Printed graphs must be taped into the lab notebook and annotated appropriately.

**Conclusions** are an important part of hypotheses testing. Did your measurements agree with the theory (within the estimated uncertainty)? If not, what is behind the difference? (Do you think there might be characteristics of the physical system that the theory is not accounting for? Are there systematic measurement errors or shifts caused by limitations of the measurement method?) Depending on the lab, a question from the manual may ask you to make such a

comparison; you can refer to your answer instead of repeating it in the conclusion. Generally, the conclusion is a spot where you can summarize how things went.

Each lab report in the lab notebook (journal) should roughly follow this basic outline. Sections 1-4 will be done in advance (the pre-lab as discussed above). Sections 6-8 will often be done after lab, but there may be time in some labs to do portions of these.

1. Title, date, student name, and lab partner name
2. A one or two paragraph introduction of the principles to be explored and why it is interesting
3. Theory to be tested
4. A one or two paragraph description of the methods to be used
5. Detailed procedure, data, and observations
6. Analysis and answers to questions
7. Results (summary of findings)
8. Conclusions (Did it agree? If not, why?)

Each student will prepare his/her/their/zir own lab report, even though the experiments were performed with a partner. Reporting is an individual task and responsibility. We encourage cooperative exchange, discussion, and sharing of ideas (and struggles) outside of lab. But we do not want to see duplicated reports. Reports should reflect your individual effort (wording, answers, analysis, and derivations).

Reports are due at the beginning of the next scheduled lab period. A penalty of 10% per day will be assessed each late lab report.

The prior week's lab notebooks will be returned from the grader at the beginning of the lecture period before lab (either the day before lab or the day of lab). Your first step each week will be to prepare #1 and #2 above before the start of lab. The idea is to come ready to work!

**TA Grading:** TAs are given the following outline for grading:

**Lab Report Rubric (10 points, use fractional (tenth point) values where needed)**

<b>Heading</b>	A lab title, date of lab, name, and partner's name are clearly present at the beginning of the lab report. <b>(0.5)</b>	A lab title, date of lab, name, and partner's name are missing from the lab report. <b>(0)</b>		
<b>Purpose</b>	The introduction includes ALL of the following:  The objective is clearly stated and accurately reflects the purpose of the lab. <b>AND</b> The physics principles covered in the lab are briefly discussed and include equations. <b>AND</b> A brief description of what was done to accomplish the objective is stated. <b>(0.5)</b>	The introduction includes one of the following mistakes:  An objective is stated, but it does not accurately reflect the purpose of the lab. <b>OR</b> The physics principles covered in the lab are incorrectly discussed. <b>OR</b> A brief description of what was done to accomplish the objective is stated, but unclear. <b>(0.4)</b>	The introduction includes two of the following mistakes:  An objective is stated, but it does not accurately reflect the purpose of the lab. <b>OR</b> The physics principles covered in the lab are incorrectly discussed. <b>OR</b> A brief description of what was done to accomplish the objective is stated, but unclear. <b>(0.2)</b>	The objective, physics principles, and brief description on what was done are not included in the lab report.  <b>(0)</b>
<b>Principles</b>				
<b>Roadmap</b>				
<b>Procedure</b>	A description of what was done to accomplish the objective is clear enough so that the experiment could be reproduced. <b>(3)</b>	A description of the experiment is included but is not clear enough so that the experiment could be reproduced. <b>(1.5)</b>	The description of what was done is missing from the report. <b>(0)</b>	
<b>Data</b>	Data is complete and is presented clearly in tables. All proper units, significant figures, and error are included. <b>(2)</b>	Data is complete but may not be presented in a neat manner or is missing some proper units, significant figures, and error. <b>(1.5)</b>	Data is incomplete (missing measurements, observations, or given information). <b>(0.5)</b>	Data is not present in the lab report. <b>(0)</b>
<b>Calculations/ Results/ Analysis</b>	A sample of all calculations is correctly presented in a neat, orderly fashion with the remaining results clearly presented. All formulas and units are present. All analysis questions in manual are answered. <b>(2)</b>	A sample of all calculations is present but:  includes minor errors, is not presented in a neat, orderly fashion, <b>OR</b> is missing formulas or units, <b>OR</b> some analysis questions in manual are unanswered. <b>(1.5)</b>	Some sample calculations are missing from the lab report, <b>OR</b> there are some major errors in the calculations, <b>AND</b> analysis questions are unanswered. <b>(0.5)</b>	The calculations are incomplete error or are missing from the report. <b>(0)</b>
<b>Conclusion/ Discussion</b>	The conclusion includes a discussion of the results and cites specific evidence, discusses the validity of the experiment <b>including experimental error (e.g. t-test)</b> , and suggests methods of improvement. <b>(1)</b>	The conclusion lacks one of the following:  citing of specific evidence, <b>OR</b> discussion of validity/error, <b>OR</b> methods of improvements. <b>(0.7)</b>	The conclusion lacks two of the following:  citing of specific evidence, <b>OR</b> discussion of validity/error, <b>OR</b> methods of improvements. <b>(0.3)</b>	The conclusion is grossly incomplete or is not present.  <b>(0)</b>
<b>Figures</b>	Figures are correctly completed with title, labeled axes, units, fit, error bars, captions, etc. <b>(1)</b>	Figures are missing either a title, labeled axis, units, fit, error bars, or caption. <b>(0.7)</b>	Figures contain major errors. <b>(0.3)</b>	Figures are missing from the report. <b>(0)</b>

**Lab Groups:** Students will work in groups of 2 (maximum of 3). It is essential that all members of the group share in the different aspects of the lab and become completely familiar with operating the equipment and computer, taking the measurements, and analyzing the data. It is best if student roles are changed from week to week; this will ensure that you are prepared for the lab practical.

**Preparation for Laboratory:** Advance preparation is essential for the efficient use of the limited lab time. Students are expected to be thoroughly familiar with the purpose and general procedures of the experiment before coming to lab; theory and procedure summaries should be prepared in advance and recorded in the lab notebook. The primary purpose of the Pre-Lab Moodle exercise is to encourage and reward preparation for lab (both in grade and ease of carrying out the experiment). Each student must bring his/her/their/zir lab manual to lab.

**Attendance:** Students must arrange in advance to attend a lab at other than their scheduled time. It is the responsibility of the student to consult with the instructor during the first week of the semester regarding any anticipated absences due to field trips, athletic events, musical performances, or other activities. Because of equipment conflicts and other logistical reasons, in general it will NOT be possible to make up a lab outside of a scheduled lab session. Lab equipment is dismantled and next week's lab is set up typically on Thursday afternoon.

**Honesty:** Students are expected to follow the Gustavus honor code: *On my honor, I pledge that I have not given, received, or tolerated others' use of unauthorized aid in completing this work.* Please ask if you have any questions about the appropriate use of another student's work.

**Evaluation:** Pre-Lab Exercises 20%, Written Lab Reports 80%

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

**Final Grades:** Final course grades will be assigned using the following scale as a guide only:

A	94-100	A-	90-94	B+	86-90
B	82-86	B-	78-82	C+	74-78
C	70-74	C-	66-70	D+	62-66
D	58-62				

Final grades may also take into account the instructor's evaluation of the student's attendance, participation, effort, and evidence of improvement or regression.

**Office Hours:** Each instructor will post their scheduled office hours outside of their offices, but it is always okay to ask questions anytime they are available.

**Requesting Accommodations:** Gustavus Adolphus College is committed to ensuring equitable and inclusive learning environments for all students. If you have a disability and anticipate or experience barriers to equal access, please speak with the accessibility resources staff about your needs. A disability may include mental health, attentional, learning, chronic health, sensory, physical, and/or short-term conditions. Students with a documented elevated risk of COVID-19 may also request academic accommodations. When appropriate, staff will guide students and professors in making accommodations to ensure equal access. Accommodations cannot be made retroactively; therefore, to maximize your academic success at Gustavus, please contact them as early as possible. Accessibility resources staff are located in the Academic Support Center (<https://gustavus.edu/asc/accessibility/>) (x7227). Accessibility Resources Coordinator, Corrie Odland, ([codland@gustavus.edu](mailto:codland@gustavus.edu)), can provide further information.

**Multilingual Student Support:** Some Gusties may have grown up speaking a language (or languages) other than English at home. If so, we refer to you as “multilingual.” Your multilingual background is an incredible resource for you, and for our campus, but it can come with some challenges. You can find support through the Center for International and Cultural Education’s (<https://gustavus.edu/cice/>) Multilingual and Intercultural Program Coordinator (MIPC), Pamela Pearson ([ppearson@gustavus.edu](mailto:ppearson@gustavus.edu)). Pamela can meet individually for tutoring in writing, consulting about specific assignments, and helping students connect with the College’s support systems. If you want help with a specific task (for example, reading word problems on an exam quickly enough or revising grammar in essays), let your professor and Pamela know as soon as possible. In addition, the Writing Center (<https://gustavus.edu/writingcenter/>) offers tutoring from peers (some of whom are themselves multilingual) who can help you do your best writing.

**Mental Wellbeing:** The Gustavus community is committed to and cares about all students. Strained relationships, increased anxiety, alcohol or drug problems, feeling down, difficulty concentrating, and/or lack of motivation may affect a student’s academic performance or reduce a student’s ability to participate in daily activities. If you or someone you know expresses such mental health concerns or experiences a stressful event that can create barriers to learning, Gustavus services are available to assist you, and include online options. You can learn more about the broad range of confidential health services available on campus at <https://gustavus.edu/counseling/> and <https://gustavus.edu/deanofstudents/services/>.

**Title IX: Sexual Misconduct Prevention and Resources:** Gustavus Adolphus College recognizes the dignity of all individuals and promotes respect for all people. As such, we are committed to providing an environment free of all forms of discrimination including sexual and gender-based discrimination, harassment, and violence like sexual assault, intimate partner violence, and stalking. If you (or someone you know) has experienced or is experiencing these types of behaviors, know that you are not alone. Resources and support are available; you can learn more online at <https://gustavus.edu/titleix/>.

Please know that if you choose to confide in the lab instructors, they are mandated by the College to report to the Title IX Coordinator, because Gustavus and they want to be sure you are connected with all the support the College can offer. Although it is encouraged, you are not required to respond to outreach from the College if you do not want to. You may speak to someone confidentially by contacting the Sexual Assault Response Team (SART/CADA),

Chaplains, Counseling Center, or Health Service staff; conversations with these individuals can be kept strictly confidential. SART/CADA can be reached 24 hours a day at 507-933-6868. You can also make a report yourself, including an anonymous report, through the form at <https://gustavus.edu/titleix/>.