# Introduction to Physics 1111K

## The Course

Much of the material covered in the lab is also covered in the lecture course, but not always in the same order. This means that the lab requires separate preparation. Students should prepare for each week's experiment by reviewing the previous week's experiment, reading the upcoming experiment, and by looking up relevant topics in the textbook and other sources, such as ***hyperphysics***. There are many helpful web pages covering the lab topics. These topics are listed at the start of every experiment.

A successful student in the labs will develop ability in general physics laboratory skills such as taking and recording data accurately, analyzing data and graphing results. Students will also be expected to demonstrate critical thinking skills such as being able to make reasonable predictions and hypotheses from known facts, being able to see the relationship between experiments and equations and seeing how they apply to the real world.

The lab reports will include data, calculations and graphs as well as analyses and answers to questions. Some questions will call for calculations, others for short answers or essays.

The lab periods are much less formal than the lectures. Students will work together in groups and are encouraged to discuss their results and questions with the instructor and each other. **Each student is, however, expected to do his or her own work and to turn in a complete set of data, graphs, calculations, and answers**.

## Materials

Students must bring either a laptop or printed version of the procedure section of the experiment, **printed** data and answer sheets, a metric ruler (the inexpensive, flexible, clear plastic ones work the best) and a calculator each week. The calculator need not be too elaborate, but it should have trig functions and scientific notation.

Every student must have the lab materials before he or she can attend a lab. A student who does not have materials for the first experiment will receive a zero for that experiment. Students who do not have materials by the second week will be dropped from the rolls for non-attendance.

## Format and Policies

There will be eleven lab meetings and two meetings for assessment testing each semester
When you registered, you signed up for a specific lab section. Each section meets once a week, twice a week in summer. You may permanently change lab sections only with the approval of the lab supervisor and the instructor of the section into which you want to transfer.

Each week's meeting begins with a fifteen minute quiz. Some of the questions will cover old material and some will cover the reading for the upcoming experiment. Students who arrive late will not be given extra time or any other chance to take the quiz.

The lab format is the same every week. After the quiz the instructor will briefly explain how the equipment works. Students will then divide into groups of two or three (no more than three) and conduct the experiment. **All the work for the experiment is due at the end of the period. Instructors will not grade or give credit for experiments turned in after the end of the lab period.**

University policy requires that all cell phone, pages, and similar devices must be turned off and earphones must be removed. Students using such things, laptops, or anything with earphones during quizzes will receive a zero grade for that quiz. Students who consistently violate this policy can have their grades reduced or be asked to leave the lab and receive a zero for that week.

## The Role of the TA

The teaching assistant is there to help you learn as much as possible from each experiment. His or her job is to explain the procedures, fix any problems with the equipment, monitor students' work and give a fair evaluation of lab reports and quizzes. The TA is not there to tell you the answers to the questions in the lab manual, but rather to guide you as you find the answers for yourself.

## Making up missed work

You may not make up a missed experiment during the first two weeks of labs. After that, students are allowed a maximum of two make up labs per semester. Labs may only be made up during the week that particular experiment is taught. You may attend another section only if there is space and the instructor agrees to accept you. You must completely and correctly fill out a Make up Lab Form and give it to the instructor befor the quiz. If your form is not legible and complete you will not get credit for your work. You may not go to more than two make up labs without written permission from the lab coordinator. **There is no other provision for making up missed work.**

## Equipment

The equipment for each experiment is usually set out on lab carts and students collect and return their own equipment. When you are finished with the equipment show your instructor that you have put it away properly. If you are careless with equipment or do not put it away neatly points will be deducted from your grade. Remove your trash.

Please be careful with the equipment. If something seems to be missing or broken, ask the instructor for help. Much of the equipment is very expensive and all of it is paid for with your tax and tuition money.

Every member of the class is responsible for seeing that the equipment is put away neatly for the next group. Your instructor should not have to clean up after you and has the authority to deduct up to two points from every student's grade if the equipment carts are not in good order at the end of the lab period.

## Grades

At the end of the semester the top ten grades plus the assessment test grade will be averaged to get the final lab grade. If the student took the first assessment test the lowest non zero lab grade will be replaced with a perfect score. Missing grades are averaged in as zeroes. Each professor sets his or her own policy regarding minimum lab performance necessary for a passing lab grade but most require that you attend and turn in satisfactory reports for at least seven experiments. The lab grade for the semester constitutes 25% of the final grade for the course.

1. **The lab quiz** (5 points): The 15 minute quiz is given at the start of each lab session. The quiz will include one or two questions based on the previous week's experiment and two to four questions concerning the current experiment. The quizzes will be handed out at the start of the period and collected fifteen minutes later. Students who arrive late will not be given extra time to finish the quiz.
2. **The experiment** (20 points): This grade includes points for correct data, calculations, graphs, and the answers to the questions. The point value for each part of the experiment is listed. The lab report must be turned in at the end of the period. No exceptions will be made.

### Cheating

Obviously lab partners will have identical data and people working together will have similar ideas about the experiment, but **students who copy other's work or who allow others to copy their work will not receive credit. A zero grade received for cheating may not be used as a drop grade. Students who are caught cheating more than once will be dismissed from the class and given a F for the entire course.**

### Problems and Feedback

Bring your problems concerning the lab to the lab supervisor, Carola Butler, room 214 NSC. The email address is butler@phy-astr.gsu.edu.

## Sources of Extra Help

***hyperphysics*** is an interactive physics program developed by Dr. Rod Nave, Associate Professor at the Georgia State University Department of Physics and Astronomy. It is available on CD ROM and on the internet at http://hyperphysics.phy-astr.gsu.edu/hphys.html. It offers comprehensive explanations of many topics as well as math review and problem solving cards. It is extremely user friendly and covers all the topics seen in the labs.

### Study Sessions

If space and personnel are available the Society of Physics Students offers free study sessions for students who want help learning to set up and solve problems. The times are usually posted on the doors of the lab rooms. These are general study sessions, not individual tutoring. You may not ask for help on problems that you will turn in for credit.

### Counseling Center

The GSU Counseling Center offers many courses on note taking, time organization, effective study habits, and overcoming test anxiety. For more information, check out their web page http://www.gsu.edu/counseling/ or call (404) 413-2000.

## Useful Definitions and Equations

1. **Significant digits**: The number of digits in a measurement indicates how precise the measurement is. The number of significant digits in a number is **not** the same as the number of decimal places. For example, both 14.1 and .000141 have three significant digits. Zeroes to the left of the number are not significant, zeroes to the right of the number are significant. Therefore 0.00025 has two significant digits and 25.00 has four. The last digit in any measurement is usually uncertain.

   There are two rules to follow when you are doing arithmetic, the **precision rule** and the **significant digit** rule:

a. ***When you add or subtract***, the precision of the answer is determined by the least precise measurement. For example:

```
   11.382      Here, 5.96 is the least precise measurement.
    5.96       The sum should be rounded to 265.35
+ 248.0042     The answer should be rounded, not truncated.
  265.3462
```

b. ***When you multiply, divide, use trig functions powers or roots***, the answer should have as many significant digits as the measurement that had the least. For example:

sin 16° = 0.28, but sin 16.0 = 0.276

```
    3.14159          This final answer can have three
*   2.54             digits and should be rounded to 7.98.
    7.979639
```

$\frac{3.22}{14.673} = 0.219$ The final answer can only have three significant digits.

Exact integers are considered to have an infinite number of significant digits. For example:

$\frac{8.965}{14} = 0.6404$ The final answer will have four significant digits.

When you do an involved calculation, carry out all the arithmetic and then round the final answer. If you round your values before you reach the final answer rounding errors will accumulate.

2. The **average**, or **mean**: This is frequently denoted by the variable letter with a bar drawn over it ( $\bar{x}$ ). Take care not to confuse this with the symbol for a vector which is similar. The equation for finding the mean is:

$$\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i$$

This means that if you have *n* values for some measurement, add them all together and then divide by *n*. The Greek letter sigma ($\Sigma$) always means "take the sum of" in this manual. For example, if you make six measurements of the length of an object and you get:
*x* = 2.45m, 2.46m, 2.43m, 2.44m, 2.45m, and 2.44m, the average would be:

$$\bar{x} = \frac{1}{6} (2.45 + 2.46 + 2.43 + 2.44 + 2.45 + 2.44) \text{ m}$$

$$\text{or} \quad \bar{x} = \frac{1}{6} (14.67) \text{ m} = 2.445 \text{ m}.$$

Note that the average has more significant digits than the individual measurements. This is because the sum of the measurements ended up with four digits. This last digit may or may not be important as it exceeds the precision of the original measuring device.
There is no way to guarantee the accuracy of any particular measurement. Therefore it is always a good idea to make many measurements and average the results.

3. **Percent error**: Use percent error to compare a result with the accepted value for some quantity. It is the absolute value of the difference between the two values divided by the accepted value and expressed as a percentage:

$$\% \text{ error} = \frac{|\text{accepted value - experimental value}|}{|\text{accepted value}|} \times 100\%$$

4. **Percent difference**: Use percent difference to compare two experimental results. It is the absolute value of the difference of the results divided by the average of the results and expressed as a percentage:

$$\% \text{ difference} = \frac{|\text{difference between the results}|}{|\text{average of the results}|} \times 100\%$$

5. **Errors**: There are two types of errors that can affect the results of an experiment. **Random errors** affect one measurement at a time. The effect of random error can be reduced by making many measurements of the same variable and averaging the results.

**Systematic errors** are caused by a flaw in the experimental design, the measuring apparatus, or the experimenter's procedure. All measurements are affected, so averaging does not improve the accuracy of the final results.

6. The **slope** of a line: Frequently you will graph one variable as a function of another. The variable that the experimenter controls is called the independent variable and is almost always plotted on the *x* (horizontal) axis. The values of the variable that is measured, called the dependent variable, are the plotted on the *y* (vertical) axis. When the instructions say to plot "*A* versus *B*", or "*A* as a function of *B*", the values for *B* go on the *x* axis and the values for *A* go on the *y* axis.

   Almost all the functions that you will plot in this course are linear, that is the data will fall on a straight line. The equation for such a line is $y = mx + b$, where *m* is the **slope** and *b* is the ***y*-intercept,** that is, t**he value of *y* when *x* = 0**. After the data points are plotted, use a ruler to draw the straight line that best fits the data. The slope of this line, *m*, tells you how *y* changes with respect to *x*. The units of the slope will be the units of y divided by the units of *x*. To find the slope of a line, pick two widely separated points that are on the line, but are not data points. They will have the coordinates $(x_1,y_1)$ and $(x_2,y_2)$. Then use the equation:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

## MAKE UP LAB REQUEST FORM

Students can attend no more than two make up labs per semester. There is no guarantee that there will be space in any particular lab section. You must have the instructor's permission to make up a lab in his or her section. Fill this form out completely and give it to the make up lab instructor before the quiz. If the form is not complete and correct you might not get credit for the experiment. If this is your 3rd (or beyond) make up lab, you need to have prior approval, otherwise no credit will be given for the make up lab. If you have scheduling problems contact Carola Butler: butler@phy-astr.gsu.edu Circle your Laboratory section from the following list.

**Physics:** **1111** **1112** **2211** **2212** **Date:** ...../...../.....

| **Experiment#:** | **Quiz Grade:** | **Report Grade:** |
|---|---|---|

| | | |
|---|---|---|
| **Your Information** | Name: | |
| | Student ID : | |
| | Email: | |

| | | |
|---|---|---|
| **Your Regular Lab Information** | Instructor's Name: | **M / TU / WED / TH / F @ ..... am/pm** |

| | | |
|---|---|---|
| **Your make up Lab Information** | I missed my regular lab because: | |
| | Instructor's Name: | **M / TU / WED / TH / F @ ..... am/pm** |
| | Instructor's Signature: | |


## MAKE UP LAB REQUEST FORM

Students can attend no more than two make up labs per semester. There is no guarantee that there will be space in any particular lab section. You must have the instructor's permission to make up a lab in his or her section. Fill this form out completely and give it to the make up lab instructor before the quiz. If the form is not complete and correct you might not get credit for the experiment. If this is your 3rd (or beyond) make up lab, you need to have prior approval, otherwise no credit will be given for the make up lab. If you have scheduling problems contact Carola Butler: butler@phy-astr.gsu.edu Circle your Laboratory section from the following list.

**Physics:** **1111** **1112** **2211** **2212** **Date:** ...../...../.....

| **Experiment#:** | **Quiz Grade:** | **Report Grade:** |
|---|---|---|

| | | |
|---|---|---|
| **Your Information** | Name: | |
| | Student ID : | |
| | Email: | |

| | | |
|---|---|---|
| **Your Regular Lab Information** | Instructor's Name: | **M / TU / WED / TH / F @ ..... am/pm** |

| | | |
|---|---|---|
| **Your make up Lab Information** | I missed my regular lab because: | |
| | Instructor's Name: | **M / TU / WED / TH / F @ ..... am/pm** |
| | Instructor's Signature: | |