INTRODUCTION AND MATH OVERVIEW

OBJECTIVES

Introduction to the most important issues in the laboratory, safety

Introduction to the requirements for the laboratory

Provide students with a list of algebra and trigonometry concepts and skills that will be essential to problem solving.

THEORY

LABORATORY SKILLS

SAFETY

The physics lab has been safe because safety has always been a priority. It is important that students will:

Arrive at lab on time and prepared. Listen attentively to instruction. Performing experiment during instruction is considered disruption.

Do not eat or drink in the laboratory. Lead and methanol had been used in the lab in the past.

Report any incidents to the instructor immediately.

Handle instruments carefully and according to instruction.

REQUIREMENTS

Bring lab manual, text book, and calculator to each lab.

Each member of the laboratory group needs to actively participate and understand ALL aspects of the experiment.

MATH REVIEW

The review materials provide a list of algebra and trignometry concepts and skills that are essential to problem solving in this course. It is strongly recommended that a student seek help with the material if needed.

SCIENTIFIC NOTATION

Students need to know how to perform the following calculations on a calculator. For multi-step calculations, keep all digits of intermediate results and round off only the final answer.

$6 * 10^{24} * 3.45 =$

$2.3 * 6.7 * 10^{-4} =$

$6.02 * 10^{23} * 1.5 =$

$$\frac{3.24 \times 10^{-21}}{9.1 \times 10^{-31}} =$$

$$\frac{3.24 \times 10^{-21}}{9.1 \times 10^{-31} \times 2.0 \times 10^{-4}} =$$

UNIT CONVERSION

25 miles = _____ meters

1 hour = _____ seconds

25 miles/hour = _____ meters/second

Discuss speed limits in residential areas.

TRIGONOMETRY

Go to the appendix for trigonometry review.

GRAPH

Students will learn to construct graphes and perform data analysis. The follow table lists time and distance data. Graph on Excel the following three graphs. Each graph should have title, subtitle, names of lab partners, labels for both x-axis and y axis.

Time t (seconds)	Distance x (meters)
1	1
2	4
3	9

Distance as a function of time, x(t) - use x as the vertical axis.
Distance as a function of square of time, $x(t^2)$ – use x as the vertical axis.

Time as a function of distance, t(x) – use t as the vertical axis.

APPLICATION OF ALGEBRA IN PHYSICS

Algebra is used in solving most of the problems in this course. However, the application may seem different than the typical problems in the algebra class. In mathematics, symbols x, y, z are usually used for unknowns; symbols a, b, c are usually used for constants. In physics,

1. All letters can be used as unknowns or constants. Displacement can be Δy or Δx.
2. A letter with a subscript is usually used to represent a particular property. Here v_0 represent the velocity at time t=0.
3. Symbols for physical properties are case sensitive. M and m are different properties.

Solve the following equations. Notice the way symbols are used to represent different properties..

1. There are four variables in the following equation. Solve for v.
   $$v^2 = v_0{}^2 + 2g\Delta y$$

   Use v_0=0, g= -9.8, and Δy= -1.00*10^3 .

   Answer the following questions before starting the calculation.

What variables are there in this equations?	
What are the unknown quantities?	
What variables are known quantities?	
We may solve for only one unknown in one equation. Is this the case?	

2. Solve the quadratic equation:
   $$y = -4.90\, t^2$$

   Use y = -1.00 * 10^{2}m. Solve for t

3. Solve for a as a function of M, m, g using the following set of linear equations:

$$\begin{cases} Mg - T = Ma \\ T - Mg = ma \end{cases}$$

What variables are there in this equations?	
What are the unknown quantities?	
What variables are known quantities?	
We may solve for one unknown in one equation or two in two equations. Is this the case?	

CALCULUS (OPTIONAL)

This is for students who have completed Calculus I.

Give the first order derivative of the following functions with respect to t.

$y(t) = v_0 t + \frac{1}{2} at^2$, where v_0 and a are constants.

$v(t) = 5.5\, t$

$y(t) = sin\ (2\pi ft + \theta_0)$, where f and θ_0 are constants.

CLEAN UP (REQUIRED)

Cleaning is required of all sessions. It helps train students a good habit and leaves the subsequent section an organized setup. Please leave five minutes at the end of the lab session for this.

Put stool back under the bench. Clean the bench top and dispose waste paper in recycle bin; dispose other waste in trash can. Ask a group member to check that cleaning is performed properly and sign below.

Inspector Signature _____

RECOMMENDATIONS (REQUIRED)

When you are through improving...you are through.

This is an exercise required of ALL laboratory sessions. It trains the students a good habit and provides valuable feedback to the course. Please leave five minutes for this.

Now reflect upon this session of the laboratory and write down what you think is good, why you think is bad, and what specific things we may do to make it better. This is required of ALL sessions of the laboratory in the school year. There is no right or wrong answer in this part. It shows your critical thinking skills, imagination, and motivation for excellence.

In the case someone think long and hard but still don't have anything to put down, write down that you have thought about it but don't have specific comment.

OBJECTIVES

Lab report format

Introduction to common laboratory equipment and maintenance

Perform measurements of length, mass, and time.

THEORY

1. All measurement results need units. What are the SI base units for the following properties?
   Length   _____
   Mass   _____
   Time   _____

2. What are the units for volume? List what you know and complete the following conversion.

   1 m^3 = _____ c.c. (cubic centimeter, or cm^3)
   1 m^3 = _____ ml

3. Write down the number of significant digits in the following measurements. Which one is most accurate?
   0.56 m   _____
   0.560 m   _____
   0.5603 m   _____

LABORATORY SKILLS

LABORATORY REPORT

Go to appendix for lab report format.

Please keep in mind that cleaning up and recommendation are required parts of the laboratory report and contribute to lab report grade. Be sure to perform properly!

Laboratory report can be turned in at the end of the lab session. Should any student need more time to complete the report, please let the instructor know and it has to be turned in at the beginning of the next lab session for earning the grade of the lab. Late lab reports will earn 50% of the grade. Measurements and practice on instruments are essential parts of the laboratory. Students who miss the lab may complete the report use data from other students measurement. These reports will earn 50% of the grade.

WHY DO WE ALWAYS REPEAT OUR MEASUREMENTS? - RANDOM ERROR HANDLING

We measure every property here three times with identical setting. That is because there is random error even when the measurement is performed carefully. The solution is to repeat the measurements and use the average value (what we've been doing). Unless otherwise specified, each measurement will be performed three times.

When students design experiment, remember to handle random error by repeating each measurement three times. If you wonder why three is the magic number here, it is not. It would be better if you have time to measure four or five times. From past experience in this class, three is the minimum number of measurements that helps effectively reduce random error.

COMMON LABORATORY INSTRUMENTS

Common instruments, as shown in the following table, are used in various experiments and are stored in specific locations. Read the Instruction and requirements carefully and consult this table throughout the semester.

Equipment	Location	Instruction & Requirements
Balance, tri-beam	bench	Calibrate zero first. Reads to 0.01g. The large one in the back of MS 306 reads to 0.1g.
Balance, electronic	back	Load objects gently. Keep doors closed. Reads 0.001g. **Unplug at the end of the lab.**
Ruler/meter stick	M-3	Reads to 0.01cm.
Metal stand	window	Heavy, handle with both hands. Return after usage.
Triangle Ruler/Protractor	M-15	Protractor reads to 0.1 degree.
White paper	front	Use both sides when possible.
computer	MS 306 MS 308	ONLY lab assignments are allowed on the computers. **Close all programs and shut down the computer after lab.**
printer	MS 306 MS 308	Each computer and laptop is connected to two printers. Select the correct printer from PRINT dialog. MS 306 printer located in MS 306. MS 308 printer located in MS 308.

INSTRUMENT MAINTENANCE

Experiment-specific Instruments are provided in cardboard containers whenever possible. An instrument log page is included in the box. Please inspect the instruments in the beginning of the lab. At the end, carefully return all of the pieces, as they were provided. All equipment should be handled carefully and gently during the experiment. This is necessary for all of our labs to run smoothly.

ORIGINAL DATA

The original measurement data are important and should be recorded and presented in the lab report. This applies to all the experiments we perform. Original data can be hand written or generated by computer software.

EQUIPMENT

Here is the list of equipment used in this experiment. Pay attention to Safety and Precaution.

Equipment	Safety & Precautions
Measurement set	
Beverage bottles	
Beakers 100 ml	
Sugar, spatula	Sugar is recycled into the bag at the end of the experiment.
Free fall apparatus	Turn on the timer only during measurements. Use reset button to set initial display The timer works the best when the ball hits the center of the probe pad. Unplug the apparatus at the end of the experiment.

To install the ball, place the ball as shown, press the Dowel pin and fasten the thumb screw.
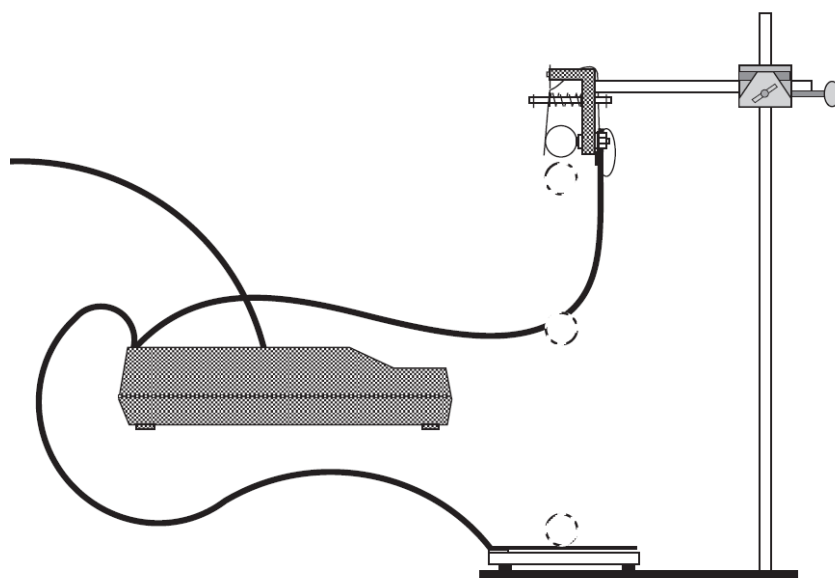
PROCEDURE & DATA ANALYSIS

SIZE AND MASS OF A BALL

Use Vernier Caliper to measure the diameter of a metal ball. Make sure that you record the correct number of significant digits for the measurement. Use tribeam balance to measure the mass of a metal ball. Enter the measured value and units in the following data table:

Measurement	Diameter Value	Unit	Mass	Unit
1				
2				
3				

Average measured diameter = _____ (reminder: value & unit)

Average measured mass = _____ (reminder: value & unit)

HEIGHT OF A BALL

Use a meter stick to measure how high the ball is when fastened in an apparatus.   Please take into consideration the size of the ball and draw a schematic diagram to show how. Keep the ball at the same position.

Measurement	Height value	Unit
1		
2		
3		

Average height = _____

TIME OF FLIGHT

Use the automatic timer to measure the time of flight of the ball free falling from the apparatus while keeping the ball at the same initial position. Record data in the following table.

Measurement	Time Value	Unit
1		
2		
3		

Average time = _____

MASS OF SUGAR

Read mass of sugar from soft drink bottle's nutrition information for each serving. Record. Calculate the total mass of sugar in the bottle, taking into consideration of the serving size. Measure the amount of sugar in a small beaker and display to one or more classmates.

CLEAN UP

Return sugar into the supply package. (Yes, we reuse chemicals in the physics lab.)

Wash the beaker with water. Turn on water cautiously to prevent splashing. Dry beaker and wipe off any water on lab benches.

Unplug all the balance. Everyone may lose some points on the lab report in case this is not done.

Inspector Signature: _____

RECOMMENDATIONS (0.2/5 POINTS): WHAT CAN BE DONE TO MAKE THIS LAB BETTER