LABORATORY INVESTIGATIONS IN PHYSICS

Major Investigations

Almost every unit will begin with a major laboratory investigation. Data and observations gathered in the laboratory should enable you to construct a model that provides a means of predicting the characteristic behavior of the system being studied. You should then be able to report the findings in a coherent and convincing argument that supports your model. The development of this argument (your lab report) based on lab data and its evaluation is critically important to your success in this class. In view of this, the following suggestions are offered to assist you in preparing your reports.

1. All major laboratory reports are to be written *in pen* on loose-leaf paper or word-processed. *You should write on one side only.* Labs may be a hybrid of handwritten work and work done on the computer. (Cut and paste or cut and tape is perfectly acceptable if done neatly.)
2. Your name, the name(s) of all members of your laboratory team and the date the investigation was turned in is to be written in the upper right hand corner of the first page of each report or on the cover page if you have one.
3. An appropriate title for the report should be placed at the beginning of the lab report.
4. Each of the following sections of the laboratory report should be prefaced with the section names. The lab should be turned in the order listed on the next page.
5. Each person in the team is to turn in a lab report. The reports for each team member may be the same except for the conclusion. Data from different teams should not be the same. (**Not applicable for ASU.)

Title	Something that pertains to the lab. (Not lab 1.) Extra credit for titles demonstrating creativity.
Purpose	This is a statement of the variable/s to be investigated. It provides the overall direction for laboratory investigation and must be addressed in the conclusion.
Apparatus	List all laboratory apparatus used in the investigation, along with a labeled diagram to indicate the configuration of the apparatus.
Procedure	In this section you should tell me the important components of how you performed the experiment. Independent and dependent variables should be identified and you should describe how the independent variable is controlled. I should be able to take your procedure and then perform the experiment as you did.
Data	Data consists only of those values measured directly from the experimental apparatus. The data should also include the measurements that you kept constant during the experiment. No values obtained by way of mathematical manipulations or interpretations of any kind are to be included in this section of the report. Data should consist of as many trials as judgment would indicate necessary (never less than five). Spread out the range of your independent variable as far as your equipment allows. Equalize the intervals between your trials as much as possible. 1. Arrange the data in a neat table. 2. Make sure you completely label the data. (If you measure the mass of something, don't just write "mass" down, write what it is the mass of. If you use abbreviations such as "m" for mass, make sure that you indicate what "m" stands for. If you want to keep your headings short, then define the heading completely before your table. 3. The units for physical measurements (kg, m, s, etc.) in a data table should be specified in column heading only.
Evaluation of Data	This section should begin with any calculated values you solved for so your graphs could be made. Show each formula used and insert data values into the formula. If repetitive calculations are to be performed, it is only necessary to substitute *only one set of data* into each formula and then construct a **table of values** for all additional calculated values. Be certain that your final calculated values are expressed to the correct number of significant figures. Do not show your arithmetic calculations. Next are the graphs that you made. Show each graph in order from test plots to linear graph. Under each graph make a statement of the shape. If the graph is not straight, make a statement about what the shape suggests you should do to linearize it. Underneath each linear graph write the equation for the graph. The equation should have the correct variables, units on the slope and intercept and a reasonable number of significant figures. If the units of the slope can be simplified, show the progression through the derivation of this unit. Then write the equation with this unit. If we agreed in whiteboarding that the intercept should be zero, don't include an intercept.
Conclusion	This is the section that will separate the A's from the B's. Even if the group has helped put the lab together, each member of the lab team is to write his or her own conclusion. Please write the

	1. State the relationship between the variables identified in the purpose in a clear, concise English sentence. Provide your justification for this statement. 2. When a mathematical expression was derived from graphical analysis, write a general equation for it. A general equation has no numbers and will apply to everyone's lab. The slope and intercept are replaced with variables. If it has been justified that the y-intercept should be zero, don't include an intercept. 3. State *what the slope represents* and speculate on what will cause it to change. (Sometimes the inverse of the slope will have meaning if the slope doesn't seem to. Use the units to try and deduce the meaning of the slope.) Remember, the slope represents something that did not change during the experiment!! Justify why you believe the slope represents this. 4. Discuss *what the y-intercept represents* (should it be zero?, why?, if it isn't zero, why not?). 5. Describe any new terms that arose as a result of doing this lab. 6. When your results differ from what is expected, indicate what was not correct. (For example, it is rare that the slope or intercept is right on.) Provide a plausible explanation for this difference. For example, describe any limitations you may have had with a piece of equipment or sources of error inherent in the equipment. If your lab results do not agree with those obtained by others, do not simply say that you must have made a mistake. The phrase "experimental error" is never a plausible explanation. Bad results due to sloppy technique on the part of experimenters are not acceptable.

Physics Laboratory Write-up Checklist

This is a sample of the type of checklist used when grading major investigations. The checklist you get when the lab is returned will be tailored for that specific lab.

Format of Lab	1. Group names, written on one side only, lab in correct order 2. Each section clearly labeled, neat and organized 3. Spelling correct 4. Punctuation, complete sentences, correct grammar 5. In ink or word processed, no fringe	_____ _____ _____ _____ _____
Title	1. Pertains to the lab	_____
Purpose	1. Relationship/s to be studied is/are clearly stated	_____
Apparatus & Procedure	1. List of equipment, diagram drawn with all components labeled 2. Clear sequence of steps 3. Control of variables is provided, dependent/independent variables identified	_____ _____ _____
Data	1. Measurements organized into a neat table 2. Values kept constant are on data page 3. Values are clearly labeled 4. Units on all values, sig figs reasonable 5. Multiple trials with repetitions 6. Range of data appropriate 7. Data of good quality 8. No calculated values in raw data	_____ _____ _____ _____ _____ _____ _____ _____
Evaluation of Data	1. Neat tables of calculated values (sig figs, units) 2. Sample calculations (put right before or after table) 3. Graphs (All graphs from first plot to linearized graph included) a. title b. variables on appropriate axes, units included c. scale appropriate d. line appropriate 4. Interpretation of graphs (put these under the graphs) a. statement on shape of graph/s, if test plot is not linear tell what you this shape indicates you should try next b. mathematical model (equation variables correct, units on slope and intercept, sig figs reasonable, slope units reduced if possible)	_____ _____ _____ _____ _____ _____ _____ _____
Conclusion	1. Written explanation (English sentences) of relationship/s a. Your justification for statements you have made 2. General equation provided (no numbers in the equation) a. The variables in the equation are defined 3. Statement of what the slope represents a. Justification for statement on slope b. Tell how slope can be increased and decreased 4. Discussion of what the Y-intercept on linear graph represents 5. Definition of new terms from the lab 6. Show awareness of error and a reasonable explanation	_____ _____ _____ _____ _____ _____ _____ _____ _____