Requirements for Lab Reports

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Labs are the heart and soul of inquiry instruction. In order for students to improve and maximize understanding of the key concepts encountered in the lab setting, it is important for students to write through lab reports. Below are guidelines for writing a quality lab report. As you conduct your lab work, keep all data collected during the lab in some sort of notebook. A three-ring binder or folder might be best, because you can include data lists and graphs generated with computer programs. All laboratory reports are to be written using a word-processor. Each lab report must include the following sections and should be prefaced with the section names. The lab report will be graded with the use of a scoring rubric.

Cover Sheet The cover sheet will contain the student's name, name of lab partners (clearly denoted as such), laboratory name, and date of exercise. On this cover sheet you will write a brief summary. The summary should address the four following items: 1) the purpose of the lab experiment (That is, what you accomplished in this exercise. For example, "In this experiment I verified Snell's law." or "In this experiment I confirmed the value of the acceleration due to gravity."), 2) a short summary of the procedure you followed, 3) what degree of accuracy you were able to achieve in your work (For example, "I verified that the angle of incidence equals the angle of reflection to within an experimental accuracy of 2%." or "I showed that Ohm's law is valid to within an experimental accuracy of 0.3%."), and 4) what the possible sources of error were (e.g., "The error in the result arises from an inability to accurately measure…"). Provides a easily understood, concise, and comprehensive overview of what is to be found in the body of the report. Uses appropriate grammar and spelling.

Purpose Starting on page two of the lab report, provide a clear and detailed goal statement of the problem to be investigated. The purpose goal statement is to explain the overall direction for laboratory the investigation and must be directly addressed in the conclusion.

Apparatus All laboratory apparatus used in the investigation, along with a detailed diagram to illustrate the configuration of the apparatus, should be included in this section. Avoid hand-drawn diagrams; utilize computer-generated diagrams. Independent and dependent variables should be clearly and correctly identified in the diagram.

Procedure This section should include a step-by-step description of the procedure used to conduct the experiment; it should also identify and name all pertinent experimental variables and briefly describe how the independent and extraneous variables are controlled. The procedure should be sufficiently clear enough so that a reader should be able to understand easily how the experiment was performed.

Data Data consists only of those values measured directly from the experimental apparatus, as well as appropriate summary representations (means and ranges, standard deviations, etc.). Data tables should be neat and orderly with no calculations or extraneous notation. Data should consist of as many trials and as wide a range as judgment would indicate necessary. The units for physical measurements (kg, cm, s, etc.) in a data table should be specified in column heading only. No values obtained by way of mathematical manipulations or interpretations of any kind may be included in this section of the report with the sole exception of data summaries such as means, error ranges, and standard deviations.

Analysis of Data Prepare your analysis sheet using the same logical order in which the experiment was performed. This section should include all graphs, analysis of graphs, and post laboratory calculations. The analysis sheet is a coherent and well-ordered presentation of sample calculations made as part of the experiment. Show all employed equations as part of your sample calculations, and identify all variables. If a graph is used, then non-linear data is linearized and linear regression using a physical model is used. Equations derived from graphs must include units, and physical interpretations given to slope and y-intercept as appropriate. All calculations must carry units throughout. Calculations must reflect an understanding of significant digits. Do a sample of each calculation performed in the experiment. Trivial calculation such as addition, subtraction, and averaging need not be included.

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Graphs If graphs are utilized, prepare using a graphing program; avoid hand-drawn graphs. Choose the limits or scale the axes so your graph fills the entire page, and data fills the entire graph. Label each graph with a title. Label and give units on each of the graph's axes [e.g., velocity (meters/second)]. The appropriate smooth curve should be drawn representing the function graphed. UNDER NO CIRCUMSTANCES SHOULD YOU CONNECT THE DATA POINTS WITH A SERIES OF STRAIGHT LINES.

If the graph of data points is a straight line, then determine the slope and write the approximate equation in your analysis sheet. If the graph is not a straight line, then you must attempt to linearize the data.

If you are calculating the slope of a graph line, be sure to include these calculations in your analysis. Give a physical interpretation to the y-intercept if possible. Note that the slope and intercept usually have units and a physical meaning. These must be included in your analysis Do not perform calculations on the data sheet or graphs.

Accuracy Each student's work should reflect the fact that care was taken in all measurement processes. Though the accuracy of your results will vary from experiment to experiment, overall error should be relatively small throughout.

Percent error or percent difference are reported as appropriate using the following definitions:

$$\% \text{ error} = \frac{\left| \text{theortical value} - \text{ experimental value} \right|}{\text{theoretical value}} \bullet 100$$

$$\% \text{ difference } = \frac{\left| A - B \right|}{(A + B)/2}$$

where A and B are experimentally determined values.

Efforts should be made at error analysis. Errors in data should be propagated into error in the result using appropriate strategies. Alternatively, root mean square error should be reported and interpreted if using a graphing package to produce graphs.

If a result departs markedly from the anticipated result (as indicated by a large margin of error), a follow-up set of measurements should be made to isolate and eliminate the source(s) of error.

The integrity of the data must be preserved at all times. In no case should the student skew the data so that proper experimental results or a smaller experimental error are achieved.

Conclusion In the conclusion you must do the following:

a) The purpose statement must be directly and completely addressed in the conclusion.

b) State the relationship between the variables identified in the purpose in a clear, concise English sentence.

c) When a mathematical expression can be derived from graphical analysis, write it, making sure to include the appropriate units. State the *meaning of the slope* and discuss the *significance* of *the y-intercept* (when appropriate).

d) Describe any new terms that arise as a result of your evaluation of data.

e) When your results differ from what is expected, provide a plausible explanation.