Lab 1: Data and Error Analysis I

Name:_____ Date:_____

Partners' Names:_____

Introduction

The goal of this lab is to practice some of the basic error analysis skills that you will rely upon throughout the semester. You will make various measurements of the dimensions of a wooden block while considering the uncertainties present in the measurements. You will also use statistical methods to make quantitative estimates of the uncertainties.

Exercise 1: Measuring the Thickness of a Wooden Block

First, use the ruler to measure the thickness (the smallest dimension) of the wooden block. Each student in your group should make their own measurement, but choose only one result to report to your instructor (don't average or combine your results in any way).

1) Record the result of your measurement here, but not until your instructor tells you to do so:

Do not move on to this next part until instructed to do so by your instructor.

Next, use the caliper to measure the thickness of the wooden block six times, choosing a different spot along the length or width of the block for each measurement. Each member of your group should perform at least two of the measurements.

2) Record the results of all six measurements with their uncertainties below:

Calculate the mean thickness of the block and the standard deviation and standard error of the measurements. Each member of the group should do these calculations independently. You may do the calculations by hand or use a calculator or computer software. Record the results below.

3) Mean thickness:

4) Standard Deviation:

5) Standard Error:

Report the thickness of the block and its uncertainty two ways: the conservative approach, and the standard error method. Use plus-minus notation.

6) Block thickness with uncertainty (conservative):

7) Block thickness with uncertainty (standard error):

Exercise 2: Additional Practice

This exercise can be completed outside of lab, but you are welcome to work on it in lab if you finish the previous exercise early. It consists of several homework-style questions that reinforce the error analysis techniques learned in lab.

8) A physics student measures an angle to be $132.2 \pm 0.2°$ using a protractor. If the student followed correct procedures for reading numbers from a scale or analog meter, what is the smallest scale division on the protractor?

9) In each of the following, a measurement result is reported with an incorrect number of figures or in an improper form. Rewrite each result in proper form with the correct number of figures.

a. $v = 8.123456 \pm 0.0312$ m/s

b. $a = 33.258 \pm 0.91$ m/s^2

c. $x = 3.1234 \times 10^4 \pm 2$ m

d. $m = 5.6789 \times 10^{-7} \pm 3 \times 10^{-9}$ kg

10) A physics student measures the spring constant of a spring 10 times, obtaining the following values (in units of newtons/meter): 86, 85, 84, 89, 85, 89, 87, 85, 82, 85

Take the mean of the data to be the best value for the measurement of the spring constant, and the standard error to be the best estimate of the uncertainty. Report the best value of the spring constant with its uncertainty using plus-minus notation and the correct number of figures. Show all of your work.