PHYS 1130 PHYSICS FOR POETS LAB—FALL TERM - 2009

PRECISION AND SIGNIFICANT FIGURES

A. Precision.

If you make a measurement (such as the width of this piece of paper), you are limited by the "precision" of the measuring instrument. For example, if you use a ruler and if you really "push" your measuring instrument (breaking a millimeter mentally up into 10 parts), you might quote your measurement for the width (in centimeters) to be 21.68 cm. Here the hundredth decimal place, namely the "8", is a guess. The mark on your ruler designating 21.6 cm and the mark on your ruler designating 21.7 cm was broken mentally by you into 10 parts. The reading may have just as easily have been 21.67 cm or 21.69 cm. The precision of your measurement is said to be "to the nearest hundredth of a cm". To claim precision greater than that, for example 21.683 cm (or to the nearest thousandth of a cm), is not possible; a simple ruler is just not that precise!

Note: A line is often drawn under the limiting digit in your measurement. For example, the above measurement of 21.68 cm indicates that the measurement in all probability falls within 21.68 cm +/- .01 cm. If this is not the case--namely, you wish to quote a more conservative precision for your measurement such as greater than 21.66 cm but less than 21.70 cm for example, you should indicate that precision explicitly--namely, 21.68 cm +/- .02 cm.

B. Significant Figures.

Once you have made you measurement, you can determine the number of significant figures by simply counting: 21.68 cm has 4 significant figures. The decimal here has no bearing on how many significant figures there are.

Examples:

10.97 in has a precision to the nearest hundredth of an inch and 4 significant figures.

13.727 cm has a precision to the nearest thousandth of a cm and 5 significant figures.

Notes: 1. If a zero is merely to locate a decimal, it is not significant. A line drawn under the limiting digit is good practice in the lab and can be used to tell you both the precision and the no. of significant figures.

Examples: A measurement of 93,000,000 miles from the earth to the sun has a precision to the nearest million miles and has two significant figures. On the other hand a measurement of the width of this piece of paper of .0004 in has a precision to the nearest ten thousandth of an inch and only one significant figure.

2. Suppose we have the following rare case where a measurement is taken to the nearest ten cm and happens to fall between 49,990 cm and 50,010 cm. This measurement can be written as 50,000 cm. The digit underlined here implies precision to the nearest 10 cm; and, consequently, there are then four significant figures. (Sometimes the line is placed over the limiting digit designating the precision of the measuring instrument rather than under it.)

(Please turn over the page.)

C. Rule for Addition and subtraction (the "precision" rule):

First carry through the operation. Then round off your final answer to the same precision as your least precise measurement.

Example: ADD: 2.30 cm
1.734 cm
3.4725 cm

7.5065 cm = 7.51 cm

Here 2.30 cm is the *least* precise measurement with a precision to the nearest hundredth of a cm. In order for you to be honest with your data, you must round your final answer to the same precision as the least precise measurement. You cannot claim a precision greater that the least precise measurement in the sum.

D. Rule for Multiplication and Division (the "significant figure" rule)

Carry through the operation first. Then round off the answer to the same number of significant figures as the measurement with the least number of significant figures.

Example: Area = (0.5 ft) x (0.72 ft) = .360 ft^2 = 0.4 ft^2

Here 0.5 ft has the *least* number of significant figures namely one. The answer should be rounded off to one significant figure! Note well that once the rule for significant figures is used, the consequent precision of the final product is given as well! Here the precision of the area turns out to be no more than to the nearest tenth of a square foot!

Exception to the rule: Sometimes after having multiplied and/or divided a number of measurements, if your result happens to begin with a "1" one additional significant figure will be included in your final result.

Example: Volume = (0.4 ft^2) x (3.97 ft) = 1.588 ft^3 = 1.6 ft^3

Normally one would expect to round off so that there is only one significant figure, but since the result of the product begins with the digit "1", one *additional* significant figure is allowed--namely two significant figures. The reason for this rule is to keep from having an abrupt change in your *precision* when your product happens to turn out as 1.6 ft^3 rather than say 0.9 ft^3.