Name___________________________________ Score___________

Lab #1: Measurement
Pre-Lab

<u>Purpose</u>:

You must be able to perform measurements and make calculations from lab data during any science class, including this physics course. The purpose of this lab is to:

- practice using various laboratory measuring techniques
- read scales on various laboratory instruments to the proper precision
- differentiate between precision and accuracy
- calculate values from data gathered, using the proper number of significant digits in the final answer

<u>Background</u>:

One of the measurements that will be calculated in this lab is density.

→ What is the formula for determining density? Express this formula in both mathematical/scientific symbols and in words.

Units for density must be some form of mass unit divided by some form of volume unit. For example, you might use units such as grams per milliliter (g/mL), kilograms per liter (kg/L), or grams per cubic centimeter (g/cm^3). When calculating density it is important to use units that are comparable. For example, you probably wouldn't use kilograms, which is a large unit of mass, and milliliters, a small unit of volume, in the same density calculation.

The density of water is one gram per cubic centimeter. Objects or substances more dense than water will sink in water, and those less dense will float.

→ An object with a density of 1.34 g/cm^3 will (float/sink) when immersed in water. (circle one)

Volumes can be expressed by two different units in the metric system. Volumes of solids are usually measured in cubic centimeters, while volumes of fluids (liquids and gases) are measured in milliliters. One cubic centimeter and one milliliter are equivalent volumes. Therefore, it is simple to convert from liquid to solid volumes in metric units.

Whenever using laboratory equipment for measuring it is important to understand the concepts of precision and accuracy.

→ In your own words, write a definition of scientific *precision*.

→ In your own words, write a definition of scientific *accuracy*.

It is also important to know to how many digits you can record data values in science. When using a mechanical measuring device (i.e. triple beam balance, metric ruler, graduated cylinder), the *precision* of the device is the smallest unit marked on the device. For example, the triple beam balance used in this class is calibrated to tenths of a gram, which means it will give measurements to the tenth gram consistently through many measurements. However, when recording measurements made with this instrument they should be estimated and recorded at one measurement more precise, or in this case to hundredths of a gram.

→ To what precision will you estimate measurements made with the following instruments:

1. Metric ruler having tenth-centimeter graduations ____________________
2. Graduated cylinder having one-milliliter graduations ____________________
3. Mechanical balance calibrated to 10-gram graduations ____________________

When using electronic measuring devices (i.e. electronic scales) you simply use the measurement shown on the digital screen.

Often you will use balances, metric rulers, and graduated cylinders to make measurements in the lab, and then use these numbers in various calculations. No scientific measurements or calculations may be more precise than the instrument used to obtain those measurements. The measurement/calculation to be recorded consists of all of the digits that are known from the instrument's scale plus the last digit that you estimated. These numbers are the significant digits, or SDs, of the measurement.

Using SDs in scientific reports ensures that all scientists understand the precision of the measurements. Not using SDs or reporting a measurement to a greater precision than is possible is dishonest. If a scientist uses a measurement that has too many SDs in a calculation, the result will be incorrect in that it will appear to have a greater precision than it warrants. Incorrect conclusions are possible as a result. Some simple rules for determining SDs are:

a) The determination of SDs applies *only to measurements*. They do not apply to pure numbers or definitions, such as 60s/min.
b) All digits in a *counted number* are assumed to be significant.
c) All nonzero digits are significant.
d) All zeros between nonzero digits are significant.
e) All zeros to the right of the rightmost nonzero digit in a measurement *containing a decimal point* are significant. If there is no decimal point, they are not significant.
f) All zeros to the left of the leftmost nonzero digit in a measurement containing a decimal point are ***not*** significant.
g) All digits in the decimal portion of scientific notation are significant.

→ How many significant digits are in each of the following measurements?

87.073m __________ 0.01520kg __________ 90,009mm __________

→ Round each of the following measurements to the number of significant digits shown in parenthesis.

314.721m (4) __________ 8792km (2) __________ 0.001775L (2) __________

Rules for calculating with SDs are:

a) The answer to an addition or subtraction calculation should be rounded to the same number of decimal places (not digits) as the measurement with the least number of decimal places.

b) In calculations involving multiplication and division of two measured values, you need to round the answer to the same number of significant figures as the measurement with the least number of significant figures. The position of the decimal point has nothing to do with the rounding process when multiplying and dividing measurements.

c) When multiplying or dividing by a pure/counting number (a whole number that was not measured) the answer must have the same precision as the original measurement.

→ Perform the following calculations. Record your answers with the correct number of significant digits. Circle your final answer for each problem.

12.52 meters + 349.0 meters + 8.24 meters

Find the total mass of three diamonds that have masses of 14.2 grams, 8.72 grams, and .0912 grams.

8.3 meters X 2.22 meters

8432 meters ÷ 3

Calculate the volume of a warehouse that has inside dimensions of 22.4 meters by 11.3 meters by 5.2 meters.

Procedure:

In this lab you will be given a glass marble and be asked to find the mass of the marble using two different methods and the volume of the marble using two different methods.

→ Briefly describe one method to find mass:

→ Briefly describe another method to find mass:

→ Briefly describe one method to find volume:

→ Briefly describe another method to find volume:

→ Using these four different measurements, how many different ways can density be calculated? List formulas for each way. Use m_1 for first massing method, m_2 for second massing method, v_1 for first volume method and v_2 for second volume method.

→ Create a data table(s) that you can use in class tomorrow as you perform this lab. (your data table(s) should have rows/columns to accommodate all four of the measurements and all density calculations)