LAD B3 (pg 1 of 2) Density of Solid Objects

Name_____

Introduction:

Recall from LAD 1 the density of a substance is its mass per unit volume. It is a derived (calculated) unit and is difficult to measure directly. The mass and volume must be measured, and the resulting density can be calculated. The mass and volumes collected in this lab will be graphed and NOT calculated. Graphs can be useful as a visual representation of the data to help identify relationships and correlations.

PreLAD: **This should be done before coming to class.**

Prepare a data table to gather the four sets of data. Keep in mind that you will need three volume columns. (One for water, one for water + object, and one for the actual volume of the object.) Use excel if you like, but you may use lined paper this time if you prefer − but you must use a ruler to make columns. Don't forget your LAD # and title and name at the top.

Procedure overview: **- Goggles are not necessary for this lab**

Be sure that the object is dry when determining its mass. Use five objects (of the same material) of different masses to get more varied results for graphing purposes and so you can answer question 5. The volume of irregularly shaped objects can easily be determined by the water displacement method, since the volume of the object is equal to the volume of liquid it displaces. Put the object directly into a graduated cylinder with a pre-measured amount of water, and measure the volume increase. Be sure to use as accurate a graduated cylinder as possible based on the size of the object being measured. DO NOT DROP the objects through the bottom of the cylinder; tip the cylinder sideways and slide the object in. DO NOT FORCE the object into a cylinder, use a larger one if the object is too tight.

Part A:

1. Determine the mass and corresponding volume for 5 objects of ONE (all the same) TYPE of metal material (you will choose either aluminum or iron).
   - Remember that you will need to measure the volume of water before the object is in, and then measure the volume of water with the object in it. A simple subtraction will allow you to calculate the volume of the water displaced which is of course equal to the volume of the object.
   - Be sure you have a space on your data table for all three of the volume values.
   - Record a 6th data point for each material, (0, 0).
2. Repeat the process for a second TYPE of material (you will choose either glass rods or rubber tubes).

Part B:

3. Collect mass and volume data from the whiteboard board for two more materials different from the materials tested in Part A. (This way you will end up with four sets of data but we can finish more quickly since you only need to measure two sets.) Of course you do not need the two water volumes for each of these data, just the mass and volume of the objects.

Disposal:

All the solids should be dried and returned to their respective places on the center lab bench.

Processing the Data:

- Do NOT calculate density. Follow the directions in the graphing section to produce two graphs.

Graphing: **STOP – Before you construct your graph, read and heed the reference document: What Makes a Good Graph? You will use Google Sheets to construct your graphs.**

A. Produce TWO separate x vs y graphs. As a minimum they must be printed on half page, or larger.

B. Plot mass (y axis) vs volume (x axis) for each set of data, putting the two metal data on one graph and the two nonmetal materials on the other graph. Plot a third set of data on each graph that will represent water. (Remember that the density of water is approximately = 1 g/ml). Make sure your water line is about the same magnitude as the other two lines.

C. Even though you did not measure it, be sure and include (0,0) as a data point for all of you data sets.

D. Draw the "best straight line" (the average or regression line, Excel calls it a "trend line") for each set of data - Do **NOT** connect the dots. Use (0,0) as a data point for each type of material.

E. Determine the slope of each the lines. (You will tell Google Sheets to do this for you when you show the equation for trend lines.)

F. Set the origin of the graph is (0, 0). You can adjust this in Google Sheets if is does not happen automatically.

Post LAD Questions:

1. For these graphs, what does the slope represent? How is density related to the steepness of the lines?

2. Why were you asked (what is it useful) to graph mass vs volume and not volume vs mass?

3. Why can/should the (0,0) point be used as a data point for each type of material?

4. Why does the procedure suggest using objects of different masses, and not objects all with similar mass?

5. How is density related to whether solid objects float or sink in particular liquids?

6. In a class demonstration, we will put ice cubes, glass square, ipe, oak, pine, foam, and balsa in water. Sort all of these materials in order from most dense to least dense. Sketch a picture of what each material would look like in water.

7. Give two reasons that the water displacement method might not be suitable for all solid materials?

8. Look up the theoretical density values for glass, and the two metals tested and compare to the slope of each line.
   - Calculate % error for the three materials. Show your work for at least one of the calculations.

9. If a student opted to measure the volume before measuring the mass of their rubber tube, and as a result, the tubing was wet inside when measuring the mass, would the calculated density of that object be too large, too small, or unchanged?
   Be sure and comment on data (higher or lower) and the effect on any resulting calculations.

10. If some of the water in the cylinder splashed out while placing the object into the cylinder, would the calculated density of that object be too large, too small, or unchanged?
    Be sure and comment on data (higher or lower) and the effect on any resulting calculations.