LAD A3 (pg 1 of 2) Density of Solid Objects

Name_____Per____

Introduction:

Recall from LAD A2 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 density will NOT calculated and averaged. Graphs can be useful as a visual representation of the data to help identify relationships and correlations. We will use the graph to provide us with the densithy of each material.

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

Create a new tab in your Google Sheet. Slide the tab all the way to the left, and label the tab A3. Click on the link on the Unit A website page to get to a pre-made data table template that you can copy into your new tab in your Google Data table.

Procedure overview: **- Goggles are a must, as usual.**

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 have either aluminum or iron).
2. 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.
3. Repeat the process for a second TYPE of material (you will have either glass rods or rubber tubes)

Part B:

4. Collect mass and volume data from the second tab on the shared data table for two more materials *different* from the materials you tested in Part A. Put this data into your spreadsheet into the pink filled areas.
   (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.)

Disposal:

All the solids should be dried and returned to their respective places on your tray.

Processing the Data:

- Do NOT calculate density. Follow the directions in the graphing section to produce TWO graphs (3 lines on each graph).

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 scatter graphs. Highlight the green outlined area and insert chart. Then scroll down and check the checkbox that says "Use column C as labels." As a minimum graphs should be printed on half page, or larger. You do not have to print the data − the graphs can be dragged over the data before printing.

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 by adjusting your water data as needed.

C. Even though you did not measure it, the (0,0) as a data point is listed for all of your data sets, and will graph for each.

D. In the Chart editor → Customize → Series menu and click the checkbox for the trend line. Be sure this applies to each set of data.

E. Determine the slope by showing the equation for each the lines. Google Sheets will do this for you when in the Series menu you go to the "Label" and use the dropdown menu to select "Use Equation."

F. If not already done for you set the origin of the graph to (0, 0).

G. Go to Customize → Charts & axis titles menu to add a title (read your "Good Graphs Sheet) and axes labels.x

(Graphs worth 10 pts total)

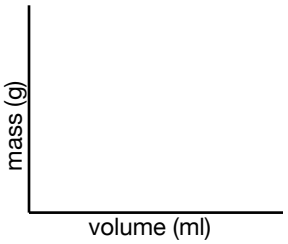
Post LAD Questions:

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

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

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

4. What would your graph look like if you chose pieces of metal all the same size? Sketch the graph.



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

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

7. 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 and report on the line below. *Show your work for at least one of the calculations to the right.*

   - Aluminum _____
   - Iron _____
   - Glass _____

8. 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 resulting effect on any resulting calculations and mark the formula.

$$D = \frac{m}{V}$$

9. 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 resulting effect on any resulting calculations and mark the formula.

$$D = \frac{m}{V}$$