Name:_____Period:_____Date:_____
Ms. Randall General Chemistry
Lab Activity: Density of Pennies

Background

Mass is a measurement of the amount of matter in a sample, while **volume** is a measurement of the space occupied by a sample of matter. Mass measurements are made on different types of balances. An electronic balance is commonly used because it gives fast results on a digital display.
Volume measurements are made in different ways depending upon the physical state of the sample being measured. The volume of a liquid is commonly measured in a graduated cylinder. The surface of the liquid curves upward where it contacts the cylinder walls. This curved surface is called a **meniscus**. Measurement of volume in a graduated cylinder is always made by reading the mark at the bottom of the meniscus with the eye positioned at the level of the liquid surface. The volume of a solid may be calculated from its dimensions (LxWxH), if the solid is regular and free of air space. However, if the solid is irregular or contains air space, its volume must be determined in another way, such as by water displacement.

The government now makes pennies that are different from the ones made before 1983. The older pennies were made of an alloy of copper which was nearly 96% pure copper. Since then, they have been made with a thin outside coating of copper (approximately 2% copper) over an inner core of a different metal (which is our unknown). The pennies appear identical in size and volume but the mass differences resulted in measurable differences in the density of pennies. We will carefully measure the mass and volumes of sets of new pennies and calculate the density. This density will allow us to determine the unknown metal that is inside the new pennies. The government changed to this metal to lower the costs of penny production, but recently the cost of this metal has jumped and it now costs about three cents in metal to produce two pennies!

Objective: To calculate density of new pennies using the slope of a line graph.

Procedure:

1. Obtain 25 new pennies (1983 or newer). Make sure that these pennies are not “cruddy” as that will cause measurement error.
2. Measure the mass of groups of these pennies, five pennies at a time (5, 10, 15, 20, and 25 pennies) and then record this data in a data table.
3. Fill a 100-mL graduated cylinder to the 20-mL mark with water. Be accurate!
4. Measure the volume of these sets of pennies, five at a time. Gently slide the pennies into the graduated cylinder as shown by your teacher. Do NOT splash the pennies into the tubes. Record the volumes of the pennies into your data table as well
5. Dry the pennies when you have finished. DO NOT PUT WET PENNIES AWAY.
6. Be neat when you make your data tables so that your information will be available to you when you need it. Be sure to use the PROPER units in your data tables.
7. Note: 1.00 mL water = 1.00 cm^3 water. Please remember: when measuring with the electronic balances, the measures go to the 100th gram.

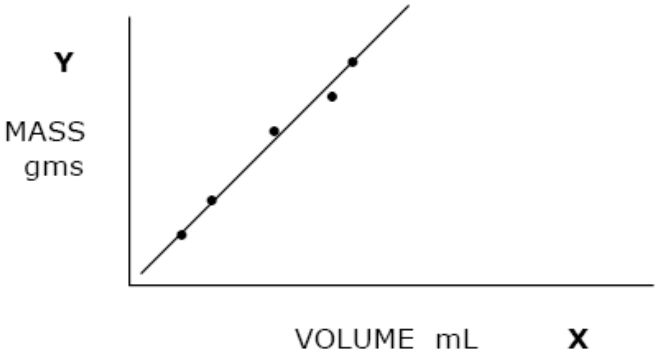
NEW PENNIES		
# of pennies	mass in grams	volume in cm^3
5		
10		
15		
20		
25		

Data Interpretation

Each student will create a large graph plotting mass as a function of volume (mass on the vertical scale or Y-axis, volume on the horizontal scale or X-axis). We will use the fact that density is equal to mass over volume, and the fact that the slope of a graph is equal to the change in Y over the change in X. Since we set mass as Y and volume as X on our graph, the slope of the line is equal to the density of the pennies.

$\text{slope} = \frac{\Delta Y}{\Delta X}$	$\text{Density} = \frac{\Delta \text{ mass}}{\Delta \text{ volume}}$	therefore, slope = density

By calculating the slope of the line, we will actually be calculating the density of the new penny.
Put the five points of data for the pennies on the graph, then draw the BEST FIT LINE, do not just connect the dots. This line must be straight!. Give your graph a sensible title and be sure each axis has a label with units.



You must use data points FROM YOUR BEST FIT LINE, which do not necessarily come from your actual data tables. We will NOT use the density equals mass over volume formula for any reason during this lab. The calculations of slope will be our "average density" for all five of our measurements.

Analysis

1. What is the slope of the "new" penny line? What is the density of new pennies?

2. Based on your calculated density and using your reference table S, which metal do you think is used in the core of post-1983 pennies? Explain your choice. State both values for comparison.

3. Find the percent error of your calculated density using the formula found on reference table T. Discuss your degree of accuracy (show calculation). The accepted value for the density of post-1983 pennies is 7.05 g/cm^3.

4. Calculate the density of a 129.5-gram sample of bronze that has a volume of 14.8 cubic centimeters. Your response must include a correct numerical setup and the calculated result.

5. A student determines the density of zinc to be 7.56 grams per milliliter. If the accepted density is 7.14 grams per milliliter, what is the student's percent error?

- Show a correct numerical setup.
- Record your answer to the correct number of significant figures.

6. Using a balance and a graduated cylinder, a student collected data on a sample of an element:

Mass of sample – 10.9 g
Volume of water – 30.0 ml
Volume of water and sample – 34.0 ml
Calculate the density of the sample. Answer must include unit.