CHEMISTRY 1H LAB: DENSITY OF UNKNOWN METALS

WHAT TO TURN IN:	Hypothesis, Data Table 1, Data Table 2, Calculations, Graph, Error Analysis, Conclusion, Questions #1-7

OBJECTIVES

- To measure the mass and volume of samples of three different metals, using the balance and water displacement
- To calculate the density of unknown metals
- To graph the combined class data and use the data to determine whether there is any constant relationship between the mass and the volume of a given substance

INTRODUCTION

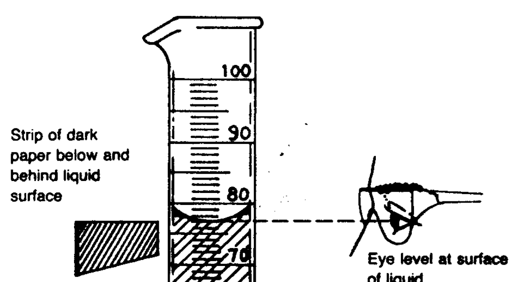
Mass is a measurement of the amount of matter in a sample, while volume is a measurement of the space occupied by a sample of matter. Mass measurements are made on different types of balances. An electronic balance is used in many high school chemistry classes because it gives fast results on a digital 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. The reading is made with the eye positioned at the level of the liquid surface. If the meniscus appears to have a thickness to it, the volume is read, at the very bottom of the thickness. A meniscus always less curved in a plastic cylinder than in a glass cylinder.

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*. Displacement measurements are made as follows. A graduated cylinder large enough to accommodate the sample of solid is partially filled with water. The volume of the water is noted. The solid is then submerged in the water, and the volume is read again. The difference between the final volume and the initial volume represents the volume of the solid. The solid must be completely submerged in the water for this method to yield accurate results, and all the air bubbles adhering to the submerged solid must be dislodged. This method is obviously only useful for solids that are insoluble in water.

PROCEDURE

1) Obtain clean, dry samples of three different metals. Write down which unknowns you have; they correspond to the answer key.
2) Measure the mass of each metal, using the maximum number of decimal places allowed by the balance (usually 0.01 g). Record in Data Table 1.
3) Measure the volume of each metal separately:
   a) Fill a graduated cylinder halfway with sink water.
   b) Tap out any air bubbles.
   c) Record the initial volume to 0.1 mL in Data Table 1.



d) Tilt the cylinder gently and slide the metal into it. It must be submerged.
e) Tap out any air bubbles.
f) Record the final volume to 0.1 mLin Data Table 1.

4) When finished, carefully pour out the water and metal into your hand. Dry the metal samples and place them back in the labeled designated containers.

CALCULATIONS

1) Calculate the volume of *each* of the metals you tested:
   VOLUME of metal = (FINAL VOLUME) – (INITIAL VOLUME) in mL
2) Calculate the density of *each* metal by **DENSITY = MASS / VOLUME**. Use the proper units and sig.figs.
   - Record your individual lab station data on the class data table.
   - Choose *one* of your unknown metals to graph. It does not have to be the same as your lab partners'. Record all class data pertaining to that metal.
   - Set up a graph. Be sure to title it and label both axes. Keep axes to consistent increments.
   - Plot a graph of the class data using **MASS as the y axis** and **VOLUME as the x axis**.
   - Use a ruler to draw the "best-fit line" through the data points and (0.0).
3) Determine the slope of your line by choosing two points *directly on the line*:

$$\textbf{SLOPE} = \frac{\textbf{RISE}}{\textbf{RUN}} = \frac{y_2 - y_1}{x_2 - x_1}$$

   - The slope of the line is the density of the metal (M/V). Record the slope in Data Table 2.
   - Look at the class density of the unknown metal you graphed, which is the slope of your line.
   - Examine your own lab group's density for the same unknown.
   - Record the standard density, given by the teacher, of the unknown that you graphed.
4) Calculate two percent errors, using absolute value if needed:

$$\textbf{\% ERROR OF CLASS} = \frac{\textbf{STANDARD – CLASS DENSITY}}{\textbf{STANDARD}} \times 100$$

$$\textbf{\% ERROR OF YOUR LAB GROUP} = \frac{\textbf{STANDARD – GROUP DENSITY}}{\textbf{STANDARD}} \times 100$$

DATA TABLE 1: MASS, VOLUME, DENSITY DATE:____________

	METAL ____	METAL _____	METAL _____
mass (g)	____________	____________	____________
initial volume of water (mL)	____________	____________	____________
final volume of water (mL)	____________	____________	____________
volume of metal (mL)	____________	____________	____________
density of metal (g/mL)	____________	____________	____________

DATA TABLE 2: DENSITY AS A SLOPE FUNCTION DATE:____________

Which unknown metal was graphed (A, B, C, or D)?	____________
slope of the line	____________
standard density value of the graphed unknown (from teacher)	____________
class percent error	____________
lab group percent error	____________

QUESTIONS

1) How can there be standard densities for substances?
2) How many decimal places should the masses have in this lab?
3) How many decimal places should the volumes have in this lab?
4) Describe how water displacement works.
5) What is a meniscus?
6) Can density be used as identification for substances in lab? Why or why not?
7) Which was more accurate, your own lab group data or the class data?