

**Chem Honors Lab [35 pts]
Measurement and Density
w/graph**

Name _____
Lab Partner _____
Date _____ Period _____

Introduction: This lab will introduce you to measurement techniques and density. You will get experience using the metric system, doing some calculations (watching units and sig figs!!), carrying out scientific problem solving and explaining density concepts.

Procedure: Carry out the tasks below. Careful measurement, data recording and problem solving will be required. **Clearly label the data you collect** (Vol? mass? length? etc..) Show all steps of your calculations. Make sure you read measurements to the **correct precision**, write **units** for every number written and keep the appropriate amount of **sig figs** throughout your calculations.

*** You may do the tasks in any order you wish. **Please write in PENCIL on the lab sheets.**

TASK 1: [3 pts] Cut a rectangular piece of aluminum foil at least 10 cm × 10 cm and determine its area, in cm². (Record linear measurements to ±0.01 cm.) Determine the mass of your sample, to ±0.01 g. Using the formula for the volume of a solid ($V = l \times w \times h$) and the density of Al (2.70 g/cm³), determine the thickness of the foil in cm and in mils (1 mil = 0.001 in and 1 in = 2.54 cm). Show all data & calculations. (Units!! Sig figs!!!)

TASK 2: [1 pt] Find the volume of a solution made by mixing 10.0mL of ethanol and 10.0mL of water.

Procedure: Obtain 10.0 mL of ethanol using a 10 mL graduated cylinder. Pour the ethanol into a beaker. Obtain 10.0 mL of water using a 10 mL graduated cylinder. Add the water to the ethanol in the beaker. Stir w/ glass rod. Now pour the total solution into a 25 mL graduated cylinder. Measure volume. Note any temperature changes.

Volume of water/ethanol solution = _____

Task 3: [2 pts] Make your own basic **Cartesian diver** by using a plastic pipet bulb (with nut).

Procedure:

- Fill a bulb with some water and place into the large beaker of water. Vary the amount of water in the bulb until you get the bulb to just BARELY float at the surface of the water.
- Now take the bulb and put it inside a plastic bottle filled with water. Put on the cap tightly. Squeeze the bottle and see your diver MOVE!!!!
- Ask me to come over and check off that you made your own Cartesian diver. _____
- Clean up-- pour the water out of the bottle (catch the diver). Return the bottle and diver so that the next group can use them.

*** Later in your post lab questions you will have to explain why the Cartesian diver goes down when you squeeze the bottle. You might want to write down some of your thoughts here right now. (They will not be graded.) *HINT: Discuss any changes to the mass, the volume, and the density of the diver.*

TASK 4: [4 pts] Choose a cylindrical metal slug. Type of metal you chose is _____
Examine slug and record any scratches or imperfections. Determine **two density values** for your slug by determining its volume by two different methods—the water displacement method and formula of a cylinder.

Mass of slug: _____

Volume of slug: *Record & label all measurements taken and show any necessary calculation of volume.*

- a) Volume by water displacement method
(place the slug into water)
- b) Volume by formula of a cylinder ($V = \pi r^2 h$)
*(measure in cm to the hundredth--
show all units in calculation)*

Calculations of density: (Show calculations of density.)

- a) Calculate density by using water displ. volume b) Calculate density by using formula of cyl. vol.

TASK 5: [3 pts] Determine the **density** of **ONE** of the three unknown liquids-- X, Y, or Z.
(Use between 10-15 mL of liquid for your investigations.) **Unknown Liquid assigned:** _____

Procedure: In stepwise fashion, write out your procedure. Specify equipment used.
(Be careful: You need the mass of the liquid only-- not the graduated cylinder too.)

Data and calculation of density: (When done, enter your density value into the Google Sheet)

TASK 6: [1 pts] Obtain a numbered metal slug from your teacher. Is your slug brass or aluminum? ____

Procedure:

- Determine the mass and volume (use only water displacement method) of your metal slug.
- Record your mass and volume values for your slug in the proper place in this chart.
- When done record your mass and volume values in the Google Sheet.
- At the end of the class you should be able to obtain all the values from your classmates for the metal you used from the Google Sheet. **(ONLY use values for the metal YOU did.)**

Metal:

# of slug	Mass (g)	Volume (mL)
#1		
#2		
#3		
#4		
#5		
#6		

Analysis of data: [6 pts] Obtain a piece of graph paper. You will be graphing the class data you have copied down for your metal--either Brass or Aluminum. Complete the following steps to successfully graph your data on the graph paper:

- For your metal, you will make a plot of mass vs. volume (mass on vertical axis). When deciding on scales for the axes, make sure both axes go through the origin (0,0) . Also, make your graph as spread out as possible. Put in your points.
- Draw a smooth “best fit” line for your points. Your line should go through the origin (0,0)
****Do not connect POINT-to-POINT. Instead, draw a line which on average goes as close to as many points as possible. The line does NOT have to go through every point.*
- Next, calculate the slope of the line.** *To do so, either approximate two points on the line or use two of your data points which happen to fall right on the line. Please do not use (0,0) as a point in your calculation. On your graph, you should label the points you will use to determine your slope. Right here, you must show the calculation of your slope. Make sure you write the units on every number in the calculation. Your final slope value must be written with a decimal (not a fraction) and also with units.*

$$\text{Slope} = \frac{\text{rise}}{\text{run}} =$$

- Using the units on your slope value as a hint, write a sentence explaining what physical property the slope of the line represents?**
- On graph paper, give your graph a descriptive title (not just mass vs. volume!!). Also, check to make sure you have labeled your axes with units.

Post Lab Questions: Answer on a separate sheet of paper.

- 1) **TASK 2:** [2 pts]: Common sense tells us that 10.0 mL + 10.0 mL equals 20.0 mL. However, your experimental results from **TASK 2** should not support this common sense view. Discuss your results and give a possible explanation for them. (*Assume that there was not any significant loss when transferring the liquids*) Hint: Think about what happens when one mixes marbles and sand.

NOTE: If you don't believe your results, I will do another demo to try to convince you that volumes are not always additive.

- 2) **TASK 3:** [3 pts] Why does a Cartesian diver go down when you squeeze the bottle?
(*Make sure to state any changes in the mass of the diver, the volume of the diver and the density of the diver.*)

- 3) **Task 4 :** [2 pts] Here are the accepted density values for the metals of slugs you could have chosen:

Aluminum = 2.70 g/ml Zinc = 7.14 g/ml Brass = 8.25 g/ml Iron = 7.84 g/mL
Copper = 8.92 g/ml Tin = 7.31 g/ml Lead = 11.34 g/ml

- a) You determined two density values for your metal slug. Determine the percent error for each of your density values. (You need to show both calculations in full.)

$$\text{percent error} = \frac{\text{accepted density} - \text{experimental density}}{\text{accepted density}} \times 100$$

- b) Which of your two density values gave a more accurate value for the density of that metal? Give a reasonable source of systematic error in which could explain why the one value was more accurate than the other.

- 4) [2 pts] **TASK 5.** Calculate the class averages of each liquid (show work!), then use the averages to determine the probable identity of each the unknown liquids (X, Y and Z). If there is more than one probable choice, but both possibilities down. A list of possible liquids and their accepted densities are given below:

gasoline	0.66 g/ml	Turpentine	0.74 g/ml	Glycerin	1.20 g/ml
Ethyl alcohol	0.79 g/ml	water	1.00 g/ml	chloroform	1.49 g/ml
		ethylene glycol	1.11 g/ml	mercury	13.6 g/ml

- 5) [2 pts] Calculate the volume of a substance which has a mass of 54.5 g and a density of 2.5 g/ml. (*Show set up-- rearrange equation with no numbers, plug in numbers and solve. Units!! Sig figs!!*)
- 6) [4 pts] Read the attached *Chem Matters* article about Archimedes. Explain how Archimedes showed that the crown was **less dense** than pure gold. Be careful—don't just explain why the crown did not have the **same** density. PLEASE-- *Make sure you describe his experimental procedure for water displacement and be careful that you use scientific terms properly. You must properly compare the properties (mass, volume, and density) of the crown to the pure gold block. Also, write answers in your OWN WORDS!! To do so, read the article first. Then try to write your answer without referring to the article. Make it make sense to you.*

Extra Credit: [1 pt maximum] Look at the **Galileo Thermometer**. This thermometer is able to measure temperature within 4°F. Your task is to explain how it works. In particular, you must **explain why a floating bulb will sink when the air temperature increases**.

(*There is obviously a connection with density, so make sure your explanation includes the concept of density. You may do research (Internet etc.) but your answer must be in your own words. You must photocopy and attach any articles that you used to answer the question. Please be aware that the info which is on a Galileo Thermometer box is not enough information to fully answer this question.*)