Name/Lab Partners_____H Chem, Period _____

Density of Brass: Accuracy and Precision

Introduction

Density is a measure of a substance's mass-to-volume ratio. For liquids and solids, density is usually expressed in units of g/mL or g/cm^3; these are equivalent since 1 mL is exactly equal to 1 cm^3. Density is an **intensive property** meaning that a substance's density will be the same regardless of the size of a sample. For example, steel has a density of 7.85 g/cm^3 whether you have a tiny steel ball bearing or a large steel beam. The mass and volume of each piece will be different, but the **mass-to-volume ratio** is the same!

In this lab, you will determine the density of brass as measured by two different techniques: 1) volume calculation using calipers to measure the radius of a cylinder and 2) volume calculation based on water displacement. You will then analyze the two methods regarding accuracy and precision of your technique.

Accuracy is a measure of how close your measured value is to the correct value. For example, if a substance has a density of 1.23 g/mL and you measure its density to be 1.24 g/mL, then you are accurate. The difference between the experimentally measured value and the accepted value is very small.

Precision is a measure of how close repeated measurements are to each other. For example, if you measure a substance with an actual density of 1.23 g/mL four times and calculate densities of 1.430 g/mL, 1.431 g/mL, 1.431 g/mL, and 1.429 g/mL, your measurements are very precise since the difference between the highest and lowest measurement (the range) is small. However, these measurements are not accurate since they differ greatly from the accepted value of 1.23 g/mL. Ideally, your measurements should be both accurate and precise.

Equations to use for the calculations:

Volume of a cylinder: $V = \pi r^2 L$

Volume by displacement: $V = V_{Final} - V_{Initial}$

$$\text{density} = \frac{\text{mass (in g)}}{\text{volume (in cm}^3 \text{ or mL)}}$$

Average density = $(d_1 + d_2 + d_3 + d_4)/4$

$$\text{Percent Error} = \left| \frac{\text{experimental value - accepted value}}{\text{accepted value}} \right| \times 100$$

Recall that this is <u>absolute value</u> so there are no negative percent error values.

Materials:

3 different sized brass cylinders
1 caliper set to millimeters
1 graduated cylinder
1 rubber stopper
250 mL beaker for water
calculator
pen
Lab Report Worksheet

Procedure

1. Weigh the mass of the three different brass cylinders. Record the data in the appropriate data table.
2. Use calipers to measure the length and diameter of the four different brass cylinders and record the data.
3. Perform the following calculations making sure all work is neatly shown under the "Calculations" section of the lab report. You must keep track of your significant figures through each calculation and show all work.

Convert the caliper readings from mm to cm.
Calculate the radius and volume of the brass cylinder.
Calculate the density of the brass cylinder.
Calculate the average density for brass.
Calculate the percent error. ***The accepted value of density is 8.470 g/cm^3 for brass.***

4. Place a rubber stopper on the bottom of a 50 mL graduated cylinder to serve as a cushion and prevent breakage. Add approximately 30-35 mL of water to the graduated cylinder (this should be sufficient to cover the largest brass cylinder when it is placed in the glass graduated cylinder).

5. Carefully insert one brass cylinder into the glass, graduated cylinder by tipping the cylinder and sliding the sample down the side. Measure the volume of the water, stopper and brass cylinder to the proper number of significant figures.

6. Repeat Steps 4 and 5 for each remaining brass cylinder.

7. Perform the following calculations making sure all work is neatly shown under the "Calculations" section of the lab report:

Calculate the volume of each brass cylinder using the volume by displacement formula.
Calculate the density of each brass cylinder.
Calculate the average density.
Calculate the percent error. ***The accepted value of density is 8.470 g/cm^3 for brass.***

Clean-Up: Rinse everything well with tap water followed by a quick DI water rinse. Clean your benchtop. Put all equipment back exactly where you found it.

Density of Brass Lab Report - 85 pts

Data Table 1: Density Using Calipers Data Table (9 pts)

Brass (3 cylindrical samples)

Cylinder #	Mass (g)	Length (mm)	Diameter (mm)

Data Table 2: Density Using Graduated Cylinder Data Table (9 pts)
Brass (3 cylindrical samples)

Cylinder #	Mass (g)	Volume water + stopper (mL)	Volume water + stopper + brass cylinder (mL)

Observations (3pts): *Write your observations of the different pieces of metal and anything else pertinent. Include color, state of matter, odor, texture, and any other pertinent information for both the brass pieces and the water used in today's lab.*

Calculations for Data Table 1: *(Show all work for the calculations beginning with formula for the first example. BE NEAT. If I can't find your calculations, it will not be graded. Label everything. Include length in cm, diameter in cm, radius, volume, and density. Correct units and significant figures will be graded.)*

Cylinder 1 **(5 pts)**:

Cylinder 2 **(5 pts)**:

Cylinder 3 **(5 pts)**:

Average Density (2 pts): *(Show all work for the calculation of average density. Begin with formula. Correct units and significant figures will be graded.)*

Percent error (2 pts): (*Show all work for the calculation of percent error. Begin with formula. Correct units and significant figures will be graded.)*

<u>Calculations for Data Table 2</u>: *(Show all work for the calculations. Begin with formula for the first example. BE NEAT. If I can't find your calculations, it will not be graded. Label everything. Include total volume, and density. Correct units and significant figures will be graded.)*

Cylinder 1 **(2 pts)**:

Cylinder 2 **(2 pts)**:

Cylinder 3 **(2 pts)**:

Average Density (2 pts): *(Show all work for the calculation of average density. Formula was shown above, so you do not need to repeat it. Correct units and significant figures will be graded.)*

Percent error (2 pts): (*Show all work for the calculation of percent error. Formula was shown above, so you do not need to repeat it. Correct units and significant figures will be graded.)*

Results:

Results Table 1: Density Using Calipers Results (15 pts)

Cylinder #	Length (cm)	Diameter (cm)	Radius (cm)	Volume (cm^3)	Density (g/cm^3)

Average Density (1 pt) (Measurement method)	
Percent Error (1 pt)	

Results Table 2: Density Using Graduated Cylinder Results (6 pts)

Volume (mL)	Density (g/mL)

Average Density (1 pt) (Displacement method)	
Percent Error (1 pt)	

Conclusion **(10pts):**

In your own words, summarize the results for determining the density of brass using the two methods: volume by measurement and volume by displacement. You are required to include the average density results from each method as well as the percent error. Be sure to summarize your results regarding the accuracy and precision of the two methods used to find volume. You are required to include the percent error results in your discussion of accuracy and precision to support your claims. *According to your experimental results* which method (caliper or graduated cylinder) of determining volume gave the more accurate density and the more precise density?