Riverside Community College

Physics 4-C

LABORATORY REPORT 4

Density of different pieces of metal

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1 Introduction

In this lab we experimentally find the density of two different pieces of metal. During this process we will also experimentally find the density of water.

2 Methodology

The process to achieve our experimental values will be identical for finding both the silver 10 gram piece of metal and the gold 50 gram piece of metal.

2.1 Setup

1. In order to start the experiment you need to find the mass of of your measuring cup without water then the mass of your measuring cup with water.

2. Next elevate a triple beam scale and attach a piece of rope to the bottom of the scale end and calibrate the scale.

3. Measure the volume of the water and then place and elevate your filled measuring cup so that the end of the string is fully submerged.

2.2 Procedure

You could either start with the gold or silver pieces, the process will be the same. We started with the 50 gram pieces of metals.

1. Begin by measuring the mass of an empty measuring cup. Then, fill the cup with water and measure the mass of the cup and water together.

2. Position a triple beam scale on a pole so that it is elevated above a work surface. Attach a piece of string to the hook at the bottom of the balance's pan and ensure the scale is calibrated to zero with the string in place.

3. Record the volume of water in the measuring cup. Adjust the height of the cup so that when the metal piece is attached to the string's end, it can be completely submerged in the water without touching the bottom of the cup.

3 Data

Tabulating our data received from measuring both gold and silver pieces Mass and apparent mass

Mass Apparent (g)	Mass Object (g)
50	44.50
100	88.60
150	132.45
200	176.80
250	212.70
300	252.35
350	293.40
400	353.30
450	397.50

Table 1: Gold metal pieces 50 (g) increments

Mass Apparent (g)	Mass Object (g)
10	6.60
20	13.00
30	19.30
40	25.60
50	31.90
60	38.20
70	44.60
80	50.80
90	57.10

Table 2: Silver metal pieces 10 (g) increments

4 Analysis

4.1 Calculations

To analyze the data, we examined the total forces and leveraged the mass of the object in water with the buoyancy equation. The process involved the following manipulations to experimentally find the density of the metal pieces:

1. In our experiment, the mass of the water was 654 grams and the volume was 700 ml, yielding a density of $\rho = 0.934\,\mathrm{g/ml}$.
2. We considered the net force equation $F_{\text{net}} = m \times a$, noting that the acceleration due to gravity is counteracted by the buoyant force making the net acceleration zero. $F_{\text{net}} = 0$.
3. By analyzing the forces acting on the submerged object, $F_B + F_T + F_g = 0$. This can be written as $\rho_f V_o g + m_a g - m_o g = 0$.
4. Simplifying further, we get $\rho_f V_o + m_a - m_o = 0$.
5. Rearranging, $\rho_f V_o + m_o = m_a$.
6. Substituting $V_o = \frac{m_o}{\rho_o}$ into the equation, we get $\rho_f \frac{m_o}{\rho_o} + m_o = m_a$.
7. Simplifying yields $m_o \left(1 - \frac{\rho_f}{\rho_o}\right) = m_a$.
8. Recognizing this linear relationship, we can express it as $1 - \frac{\rho_f}{\rho_o} = \text{slope}$.
9. For our experiments, we used Excel to perform a least squares regression to find the slope. Where $1 - \frac{\rho_f}{\rho_o} = \text{slope}$.
10. We can isolate ρ_o as $\rho_o = \frac{\rho_f}{1 - \text{slope}}$, enabling us to calculate the density of the metal pieces.

Finding the slope to get the density for both metals.

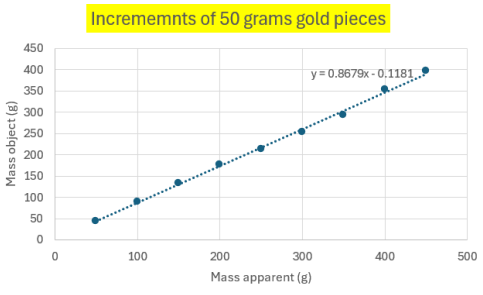

Figure 1: Gold: Mass Apparent vs Mass object

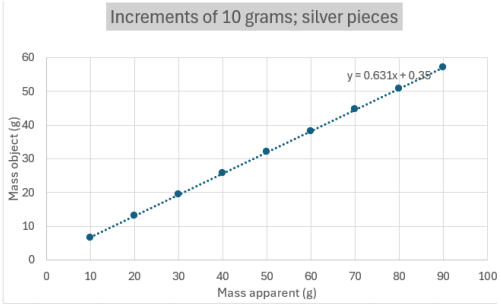

Figure 2: Silver: Mass Apparent vs Mass object

5 Result

Our experimental densities where measured to be $7.08\frac{g}{ml}$ for the 50 gram gold piece of metal, and $2.53\frac{g}{ml}$ for the silver 10 gram piece of metal. To find this we also found the density of the water to be $0.93\frac{g}{ml}$

6 Conclusion

With this experiment we experimentally found the speed of sound by using the wave speed equation.

One caveat to consider, is the measurement of the wavelengths with the meter stick may be affected by human error, as we held the meter stick elevated and was difficult to maintain balance. This caused some sound being created as the sensor would bump into the wall.

7 References

[1] Dr. Russel's Lecture 3/04/24, Riverside Community College.

Special thanks to the Cern Particle accelerator !