Brandon Sadowski

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1st Hour

Accuracy & Precision: Measuring Density

Purpose/Background: The purpose of this lab was to demonstrate both accuracy and precision. In this experiment you will determine the the density of a solid piece of Aluminum and a sample of liquid water. The true value of both Aluminum and water will help you calculate the percent error. Calculating the percent error of Aluminium will demonstrate accuracy in your measurements and calculating to demonstrate precision.

$$\text{Percent error} = \frac{|\text{accepted value} - \text{experimental value}|}{\text{accepted value}} \times 100$$

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Volume of Aluminum = Volume of water + Aluminum - volume of water in graduated cylinder

Mass of Aluminum = Mass of cylinder + water + Aluminum - Mass of cylinder + water

Materials:

Graduated cylinder	Balance
Thermometer	Periodic table

Precautions: Aluminum can be harmful in some forms but for this experiment it will be in solid form which is not hazardous.

Procedure:
Density of Water:
- Using the balance find the mass of your 10 mL graduated cylinder and record the measurement (Record after all steps if necessary)
- Fill the graduated cylinder to around 8 mL of deionized water.
- Measure the amount of water in the graduated cylinder (to 0.1 mL).
- Measure the temperature of the water using the thermometer to the nearest whole number.
- Measure the mass of the cylinder including water.
- Record the true value for density of water. (in lab)

Density of Aluminum:
- Fill the graduated cylinder to about 5 mL of water.
- Measure the volume of the water in the cylinder and record to 0.1 mL.
- Measure the mass of the cylinder and water.
- Place piece of Aluminium into the cylinder.
- Record the volume of the water after the Aluminum is added.
- Measure the mass of the cylinder with water and Aluminum.
- Look up the true density of Aluminium on a periodic table.
- Pour water out of cylinder and place Aluminum back in lab.

Data and Calculations:

Calculations for water:

Mass of water:
M = 7.9 mL*1 g/mL = 7.9 mL

Percent error:
$\frac{|1.00\ mL - 1\ mL|}{1.00\ mL} \times 100 = 0\%$ error

Density of water:
$D = \frac{7.9\ g}{7.9\ mL} = 1$

Calculations for Aluminum:

Mass of Aluminum: M = 41.6g - 32.2g = 9.4g	Class average: 2.7+2.4+2.7+2.6+2.7+2.7+2.7+2.5+2.6+2.7+ 2.9+3.1+2.7+2.6 = 37.6g/mL
Density of Aluminum: $D = \frac{9.4g}{3.5ml} = 2.7$ g/ml	Class average: $\frac{37.6g/mL}{14} = 2.68g/mL$
Percent error: $\frac{\lvert 2.70g/mL - 2.7g/mL\rvert}{2.70g/mL} \times 100 = 0\%$ error	Class percent error: $\frac{\lvert 2.70g/mL - 2.68g/mL\rvert}{2.70g/mL} \times 100 = .74\%$ error

Data Table for water:

Mass of empty graduated cylinder:	27.3g
Volume of water in graduated cylinder:	7.9 mL
Mass of graduated cylinder + water:	35.2g
Temperature of water:	24.3 degrees celsius
Mass of the water:	7.9g
Density of water at 25 degrees celsius:	1.00g/mL

Data table for Aluminium:

Volume of water in the graduated cylinder:	5 mL
Mass of cylinder + water:	32.2g
Volume of water + Aluminum:	8.5 mL
Mass of cylinder + water + Aluminum:	41.6g
Mass of Aluminum:	9.4g
Volume of Aluminum:	3.5 mL
Calculated density of Aluminum:	2.7 g/mL
Accepted density	25 g/mL

Calculated density of Aluminum/Class data: (g/mL)

2.7	2.5
2.4	2.6
2.7	2.7
2.6	2.9
2.7	3.1
2.7	2.7
2.7	2.6

Error Analysis: As shown in both the data and the percent error (pg. 2) the accuracy of the experiment was significant. For both Aluminum and water there was 0% error, meaning the experimental values gathered were the same density as the accepted value. But aside from the two, the classes percent error was calculated to .74%. One pattern in the class data was that out of the 14 measurements, half were 2.7g/mL while the other half was scattered from 2.4g/mL - 3.1g/mL. Some of the reasons for error for getting 0% could involve incorrect rounding. All the measurements were rounded to the tenths value.

Discussion and Conclusion: The purpose of this lab was to demonstrate both accuracy and precision. In this experiment you will determine the the density of a solid piece of Aluminum and a sample of liquid water. The measurements of Aluminum and water and the percent errors determine how accurate they are compared to the true values. When calculated the Aluminum should have weighed about 2.70g/mL at 25 degrees celsius. This lab relates to what we are doing in class because in order to get an accurate measurement when calculated; the number should correctly rounded using significant figures. (Accuracy) As well as precision, when calculating the class data all numbers should be relatively the same and also rounded.

Post Lab Questions:

1. **What's the difference between accuracy and precision and why do you want both in an experiment?** The difference between accuracy and precision is that accuracy is how close you are to the true value and precision is how close more than one measurements agree with one another. It's important to have both because if you have both you hit the objective completely.

2. **If a student added the Aluminum to the water in the graduated cylinder and the volume of water went above the 10 mL mark in part 2, could they just pour out some of the water, read the cylinder, and continue?** No you would not be able to just pour water out. In order to get the volume of Aluminum you need to subtract the sum of the cylinder, water, and Aluminum subtracted from the sum of the cylinder and water. By doing that, the difference is the volume of the aluminum.

3. **What are the hazards associated with Aluminum?** Some hazards associated with Aluminum are that if it's in the powder form it's extremely hazardous. If inhaled can cause scarring of the lungs. In the solid form it's harmless.