EXP. NUMBER	EXPERIMENT/SUBJECT	DATE
1.1	Density Lab 1.1	9-8-14

NAME	LAB PARTNER	LOCKER/DESK NO.	COURSE & SECTION NO.
Sarah Goldberg	Sarah Lee Samantha Kaplan Emily Markarian Raju Ivatari	3	AP

This is a fantastic lab write-up. 10/10

1. Introduction/Objective:

This lab used displacement as a method to experimentally determine density for specific materials. This change in mass and/or volume was measured for a solid, liquid, and gas which was then used to calculate density. The calculated density values can then be compared to the accepted values for those substances.

3. Procedure/Methods:

Experiment 1: Density of a Solid

1. Add approximately 10.0 mL (V_1) of water to a graduated cylinder.
2. Mass the graduated cylinder and the water (m_1).
3. Add a piece of Aluminum.
4. Record the volume to one decimal place (V_2).
5. Mass the graduated cylinder and the aluminum (m_2).
6. Repeat steps 1-5, adding an extra piece of Aluminum each time.

Experiment 2: Density of a ~~Gas~~ Liquid

1. Mass a clean, dry 10mL graduated cylinder (m_1).
2. Add 10.0 mL of water to the graduated cylinder.
3. Mass the cylinder and the water (m_2).
4. Repeat steps 1-3 two more times.

Experiment 3: Density of a Gas

1. Mass a butane lighter (m_2).
2. Fill a small, long rectangular dish about halfway with water. This dish should be able to hold a 50mL graduated cylinder vertically, so that only part of the graduated cylinder is submerged.
3. Fill a 50 mL graduated cylinder with 70 mL of water (all the way to the top).
4. Take a hard, plastic, straight object (example - ID card) and cover the top of the graduated cylinder.
5. Press the ID card to the top of the graduated cylinder and flip the graduated cylinder over. Avoid trapping air between the water and the ID card.
6. Place the graduated cylinder in the dish (being careful not to displace the ID card or spill out any water from the graduated cylinder.

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3. Procedure/Methods: (continued)

7. Put the hose of the butane lighter inside the graduated cylinder. The ID card may be displaced at this point in order to get the hose inside the graduated cylinder.
8. Press the button on the butane lighter.
9. Stop the butane when the water in the graduated cylinder reaches the graduated cylinder's tick marks and the volume of the butane gas can be measured.
10. Measure the amount of "air" or butane in the graduated cylinder (V).
11. Dry and mass the butane lighter(m_1).
12. Repeat steps 1-11 two more times.

4. Data:

Experiment 1: Density of a Solid

	$m_2 - m_1 = \Delta m$	$V_2 - V_1 = \Delta V$	$d = m/V$
Trial 1	28.804 g − 28.481 g = 0.323 g	10.1 mL − 10.0 mL = ~~0.1 mL~~ 0.1 mL	.323 g / ~~0.1 mL~~ 0.1 mL = ~~3 g/mL~~ 3.23 g/mL 3 g/mL
Trial 2	29.286 g − 28.481 g = 0.805 g	10.3 mL − 10.0 mL = ~~0.3 mL~~ 0.3 mL	0.805 g / ~~0.3 mL~~ 0.3 mL = ~~2.68 g/mL~~ 3 g/mL
Trial 3	30.819 g − 28.481 g = 2.338 g	10.7 mL − 10.0 mL = ~~0.7 mL~~ 0.7 mL	2.338 g / ~~0.7 mL~~ 0.7 mL = ~~3.34 g/mL~~ 3 g/mL

Experiment 2: Density of a Liquid

$m_2 - m_1 = \Delta m$	V	$d = m/V$
17.384 g − 7.368 g = 10.012 g	10.0 mL	10.012 g / 10.0 mL = 1.00 g/mL

Experiment 3: Density of 2 Gas

	$m_2 - m_1 = \Delta m$	V	$d = m/V$
Trial 1	16.798 g − 16.785 g = .013 g	6.45 mL	.013 g / 6.45 mL = 2.0×10^{-3} g/mL
Trial 2	14.112 g − 13.914 g = 0.198 g	68 mL	0.198 g / 68 mL = 2.9×10^{-3} g/mL
Trial 3	16.846 g − 16.798 g = 0.048 g	13.6 mL	.048 g / 13.6 mL = 3.5×10^{-3} g/mL

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5. Calculations:

Experiment 1: Density of a Solid

• Calculate the percent error between your density and the true value of 2.7 g/mL

3 g/mL
3 g/mL
+ 3 g/mL
9 g/mL

$\frac{9\,g/mL}{3} = 3\,g/mL$

$\frac{|3\,g/mL - 2.7\,g/mL|}{2.7\,g/mL} \times 100 = \boxed{10\%}$

• Calculate the number of moles of aluminum, Al.

$\frac{.323\,g}{1} \cdot \frac{1\,mol}{26.98\,g} = \boxed{.01\text{ moles}}$ $\frac{.805\,g}{1} \cdot \frac{1\,mol}{26.98\,g} = \boxed{.03\text{ moles}}$

$\frac{2.338\,g}{1} \cdot \frac{1\,mol}{26.98\,g} = \boxed{.09\text{ moles}}$

Experiment 2: Density of a Liquid

• Calculate the percent error between your density and the true value of 1.0 g/mL

$\frac{|1.00\,g/mL - 1.0\,g/mL|}{1.0\,g/mL} \times 100 = \boxed{0\%}$

• Calculate the number of moles of water, H_2O.

2(1.01 g/mol)
+ 16.00 g/mol
18.02 g/mol

$\frac{10.012\,g}{1} \cdot \frac{1\,mole}{18.02\,g} = 0.5556\text{ moles}$ $\boxed{5.56 \times 10^{-1}\text{ moles}}$

Experiment 3: Density of a Gas

Calculate the % error between your density and the true value of 2.3×10^{-3} g/mL →

.0020 g/mL
.0029 g/mL
+ .0035 g/mL
.0084 g/mL

$\frac{.0084\,g/mL}{3} = .0028\,g/mL$

$\frac{|.0028\,g/mL - .0023\,g/mL|}{.0023\,g/mL} \times 100 =$ ~~22.8%~~ $\boxed{22\%}$

Calculate the number of moles of butane, C_4H_{10}

4(12.01 g/mol)
10 (1.01 g/mol)
58.14 g/mol

$\frac{.013\,g}{1} \cdot \frac{1\,mol}{58.14\,g} = \boxed{2.23 \times 10^{-4}\text{ moles}}$ $\frac{.048\,g}{1} \cdot \frac{1\,mol}{58.14\,g} = \boxed{8.26 \times 10^{-4}\text{ moles}}$

$\frac{.198\,g}{1} \cdot \frac{1\,mol}{58.14\,g} = \boxed{3.41 \times 10^{-3}\text{ moles}}$

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6. Results / Discussion:

In the first experiment, determining the density of solid Aluminum, the measurement of three different masses of Aluminum resulted in the same calculated density. In the second experiment, determining the density of liquid water, the density of the water matched the accepted value. In the third experiment, measuring the density of butane gas, the measured densitys of three different trials varied greatly. The experiment measuring the density of liquid water was the easiest to do, and the most accurate. The density of water calculated was the same as the accepted value. The experiment measuring the density of solid Aluminum was slightly more challenging, and less accurate than the ~~liquid~~ experiment measuring the density of liquid water. The average of the calculated densities was 10% higher than the accepted value. The experiment measuring the density of butane gas was extremely challenging, and the least accurate of the three. The averge of the calculated densities was 21.7% higher than the accepted value.

There were no issues measuring the densities of the solid or the liquid. There was a problem measuring the density of the gas because the measured value was over 60% higher than the accepted vale on at least nine attempts. There were difficulties getting accurate readings from the graduated cylinder. Subsequent trials used a very thin glass tube with additional measurement tick marks than the graduated cylinder had. This decreased the inaccuracy by about half. It was unclear where the other source of error came from.

Using displacement, 3 different states of matter could be calculated relatively easily, quickly, and cheaply. No particularly specialized lab equipment was needed. And except for the experiment measuring the density of butane gas, the results were fairly accurate.

Because the measurement of the solid was fairly accurate, the sources of error were most likely human error or caused by the electronic balance. The precision of the graduated cylinder could account for the misreading of the amount of water.

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6. Results/Discussion (continued):

The electronic balance fluxuated at the 3rd decimal place, calling into question the accuracy of that value, which may account for the 10% difference. The flickering of the balance cannot account for all the error. Because although it flickered during the liquid measurement, that measurement turned out to be quite accurate, matching the accepted value. Other sources of error in the gas measuremet could include undetectable leaks in either the lighter or the graduated cylinder or human error causing an air bubble in the top of the graduated cylinder (this was visualized during several experiments).

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