

Choose one of the two metals from your samples (you will do the second metal later). Measure the mass, length, and diameter of each sample of that metal and fill in the data table with your measurements.

*When using the digital calipers, be sure to zero them when completely closed before you start. Also notice that they measure in millimeters, so you will need to convert to centimeters.*

	Metal	Mass (g)	Length (cm)	Diameter (cm)	Radius (cm)	Volume (cm <sup>3</sup> )
4	Brass	1.875	1.273	.477	.2385	.227
3	Brass	8.119	3.04	.634	.317	.960
2	Brass	5.578	3.735	.476	.238	.665
1	Brass	7.504	5.013	.475	.2375	.988

## Calculations

1. Use your computer to look up the equation for the volume of a cylinder, and write it below. Show one of your volume calculations here and fill in the table with your calculated volumes.

$$V = \pi r^2 h$$

Data Table	Metal	Mass (g)	Length (cm)	Diameter (cm)	Radius (cm)	Volume (cm <sup>3</sup> )
	Al	4.849	2.64	.947	.471	1.84
Volume of Cylinder	Al	7.410	3.875	.954	.477	2.77
$V = \pi r^2 h$	Al	9.440	4.992	.940	.470	3.46
	Al	9.423	5.122	.937	.4685	3.53

Volume sample calc:

Density:  $D = \frac{g}{cm^3}$

	Metal	Mass (g)	Length (cm)	Diameter (cm)	Radius (cm)	Volume (cm <sup>3</sup> )
4						
3						
2						
1						

↑ same

	Metal	V of H <sub>2</sub> O	Volume H <sub>2</sub> O	Volume of Slug	Sample
Pg. 10	4 Brass	7.1 (cm <sup>3</sup> )	6.9 (cm <sup>3</sup> )	.2 (cm <sup>3</sup> )	
	3 Brass	8.15	7.15	.1	
	2 Brass	7.35	7	.35	
	1 Brass	7.95	7	.95	

### Salt Water

Water Volume	Cylinder + Water (g)	Mass of H <sub>2</sub> O (g)	Calculated Density (g/ml)
2 (ml)	7.231	2.0293	1.01
4	9.613	4.413	1.10
6	11.537	5.7685	0.961
8	13.934	8.7323	1.09
10	15.986	10.7843	1.08
		Average:	1.0482

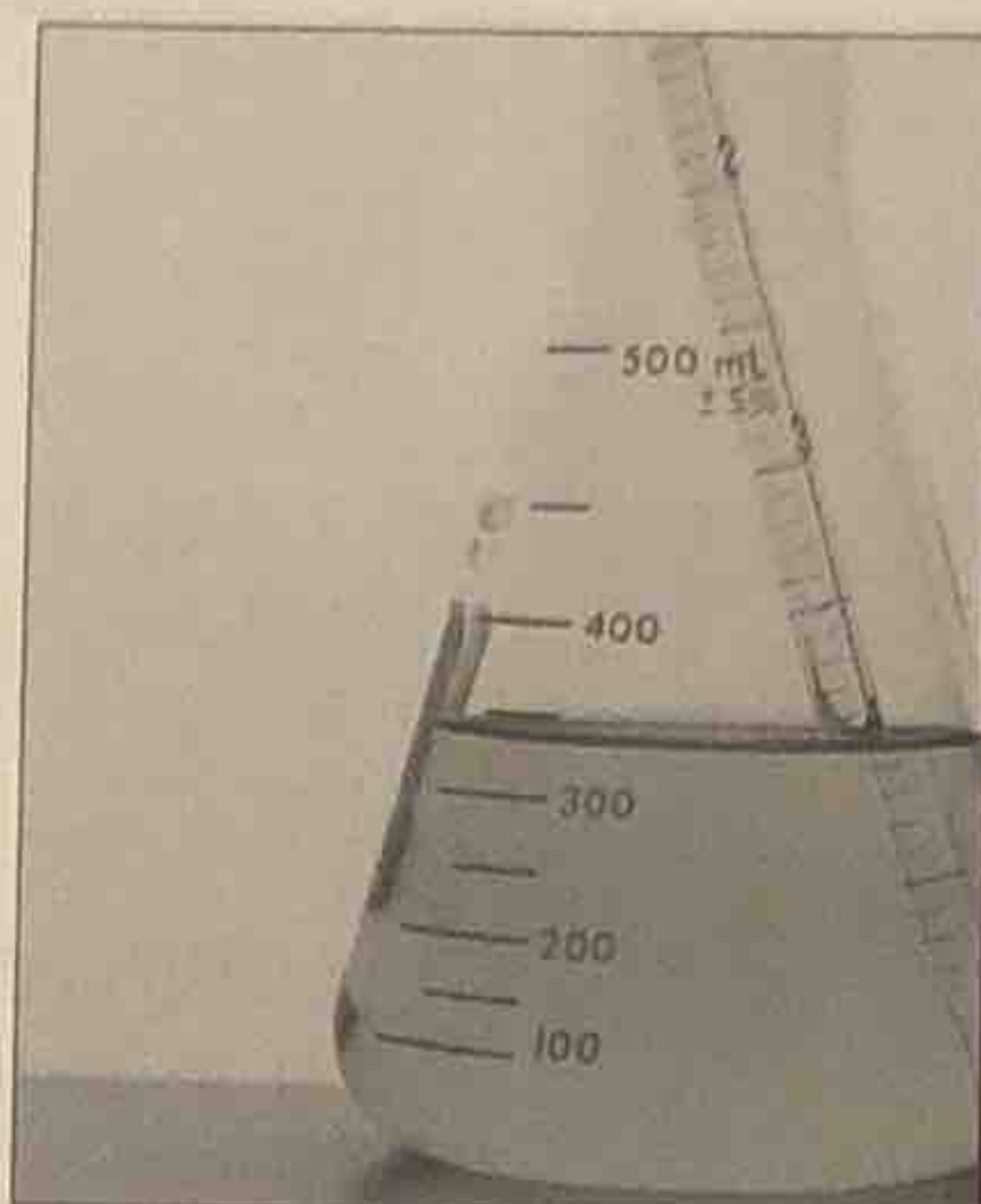
Transfer Times

### Hexane

2 mL	6.3791	1.1774	.5887
4 mL	7.7667	2.565	.64125
6 mL	8.9956	3.7939	.63232
8 mL	10.3428	5.1411	.64263
10 mL	11.8161	6.6144	.66144
		Average	.633268

## Laboratory

# 2



## Density Measurements

### Objectives

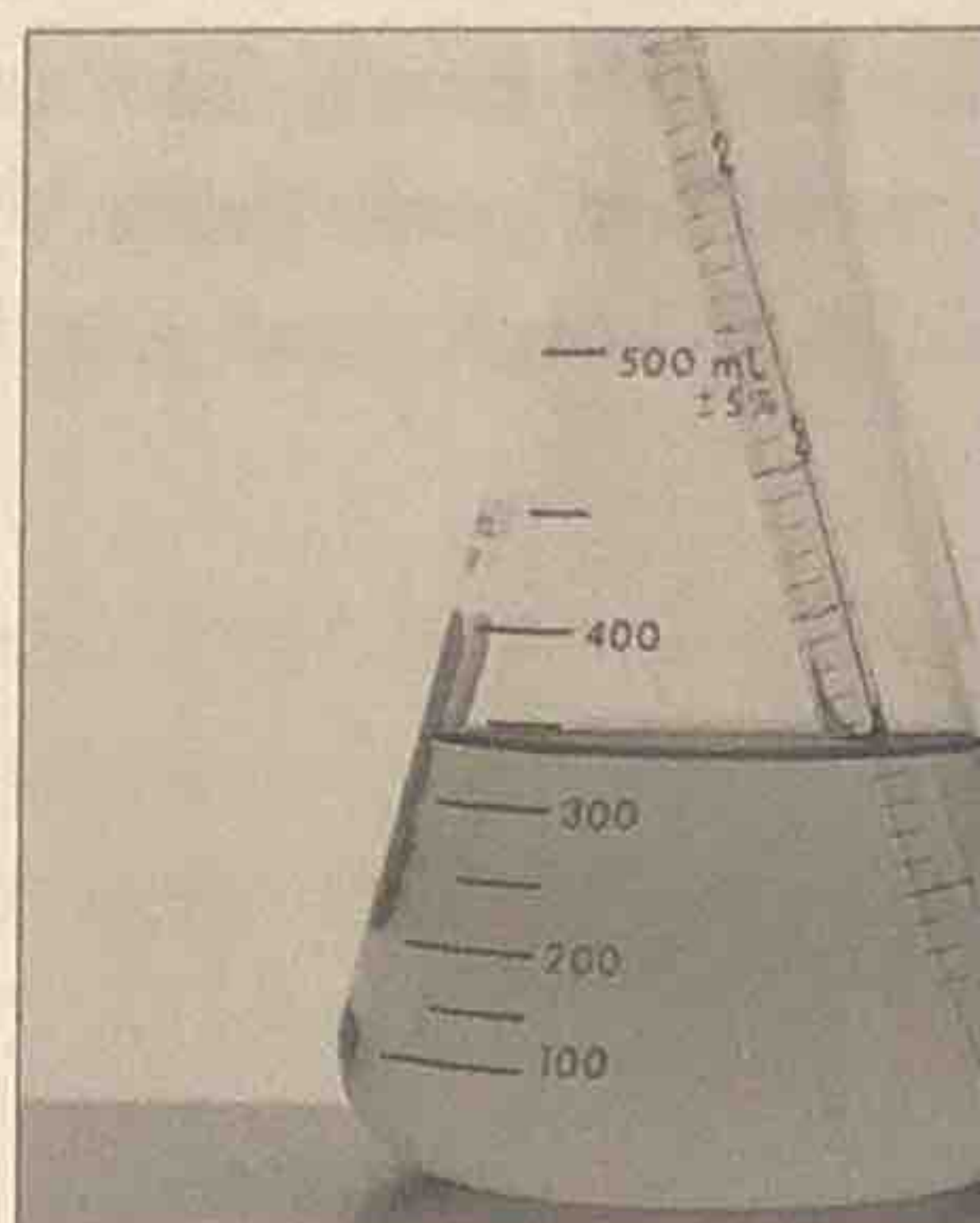
- Learn about how certain physical properties are related to each other mathematically and graphically
- Determine the density of a solid and a liquid

### Equipment and Materials

- 4 slugs of both brass and aluminum
- Digital calipers
- 10 mL graduated cylinder
- 50 mL beaker
- ~15 mL deionized water
- ~15 mL salt water
- ~15 mL hexane

### Introduction

Some physical properties of materials change with sample size, and we call those *extensive* properties. Some properties remain the same regardless of sample size. We call the latter *intensive* properties. In this lab, we are going to learn to measure extensive properties and see if we can use the data gathered to discover an intensive property.

**Laboratory****2****Worksheet**

Name \_\_\_\_\_

ID No. \_\_\_\_\_

Instructor \_\_\_\_\_

Course/Section \_\_\_\_\_

Partner's Name (if applicable) \_\_\_\_\_

Date (of Lab Meeting) \_\_\_\_\_

**VOLUME OF A SOLID****Data Collection—Part I**

1. Choose one of the two metals from your samples (you will do the second metal later). Measure the mass, length, and diameter of each sample of that metal and fill in the data table with your measurements.

*When using the digital calipers, be sure to zero them when completely closed before you start. Also notice that they measure in millimeters, so you will need to convert to centimeters.*

	Metal	Mass (g)	Length (cm)	Diameter (cm)	Radius (cm)	Volume (cm <sup>3</sup> )
4	Brass		1.273			
3	Brass		3.04 cm			
2	Brass		3.735			
1	Brass		5.013			

**Calculations**

1. Use your computer to look up the equation for the volume of a cylinder, and write it below. Show one of your volume calculations here and fill in the table with your calculated volumes.

2. Using the data for your slugs, find two variables from the previous table that can be graphed to give a linear relationship. Plot the variables using Excel or a different spreadsheet program. Find the linear fit for your data. What is the mathematical equation that relates these two variables? Sketch your graph below and include your equation.

3. What information can you get from your equation? Explain.

**Data Collection – Part II**

1. Create a new data table in your notebook similar to the table in Part I. Repeat your data collection using the slugs from the other metal, and fill in your new data table.

**Data Analysis**

1. Enter and graph your data for this metal sample using the same variables as before. Sketch your graph below and include your equation. Include on your sketch the line from your previous metal.

2. Compare the graphs and equations for the two metals. What are the similarities? What are the differences?

3. What conclusions can you reach from your data?

## Data Collection—Part III

### Volume by Displacement

1. Create a data table in your lab notebook with the following column headings: Sample; Volume of Water + Metal; Volume of Water; Volume of Slug. Allow a row for each of your metal samples.
2. Place about 5 mL of water into your graduated cylinder. Read the volume and record in your data table.
3. Place one of your metal slugs into the cylinder with the water. Be sure that the metal slug is completely submerged. If it is not, you will need to remove the slug and repeat step 2 with more water. Read and record the new volume in your data table.
4. Using the readings from step 3, find the volume of your slug and record in your data table.
5. Repeat steps 2–4 with all of your metal samples.
6. How do the values in Part III compare with the values in Part I? Are there any trends? Explain your reasoning for any differences in the volumes you find.
7. How would your new values affect the calculated value for the densities? Which method do you feel is more accurate? Explain.

**LIQUIDS**

2 mL                      4 mL                      6 mL                      8 mL  
 7.2223g / 9.0611g / 11.0198g / 12.9818g

**Data Collection**

1. Obtain ~15 mL of deionized (DI) water in a 50 mL beaker.
2. Find the mass of your 10 mL graduated cylinder and record it in the space above the table.
3. Measure approximately 2 mL of water into your graduated cylinder. (*Important: It does not need to be exactly 2 mL—just close.*)
4. Find the mass of your graduated cylinder and water and record the actual volume and mass of water in the table below.
5. Repeat steps 4 and 5 with ~4 mL, ~6 mL, ~8 mL, and ~10 mL of water and record the results in your table.

10 mL / 15.0336g

**Calculations**

1. Find the mass of each of your water samples and calculate the density of each sample. Also calculate the average density of your samples and record the result in the space provided. Show one example of each calculation below the table.

7.231g / 9.613g / 11.537g / 13.934g / 15.934g

Mass of empty graduated cylinder: 5.2017 g

	Actual Volume of Water (mL)	Mass of Graduated Cylinder and Water (g)	Mass of Water (g)	Calculated Density (g/mL)
2 mL	2 mL	7.2223g	1.8206	0.9103
4 mL	4 mL	9.0611g	3.8594	0.96485
6 mL	6 mL	11.0198g	5.8181	0.9696
8 mL	8 mL	12.9818g	7.7801	0.9725
10 mL	10 mL	15.0336g	9.8319	0.98319

Average calculated density 0.96088 (g/mL)

**Data Analysis**

1. Are the density values for each of your water samples similar or different? Explain why you think that is.

2. Find the actual density for water at room temperature ( $\sim 25^{\circ}\text{C}$ ). How does your average value compare? What factors do you think may have contributed to any error?

3. If you had graphed the same set of variables for the water as what you had for the metal samples, how would the graphs compare?

**Data Collection**

1. Rinse your 50 mL beaker and obtain  $\sim 15$  mL of saltwater.
2. Create a table in your lab notebook similar to the table in the previous procedure. Use the same mass for the graduated cylinder.
3. Follow the same procedures as in steps 3–5 in the previous Data Collection section and record your data in your table.

**Calculations**

1. Calculate the density of each saltwater sample. Also calculate the average density of your samples and record the result in your lab notebook.

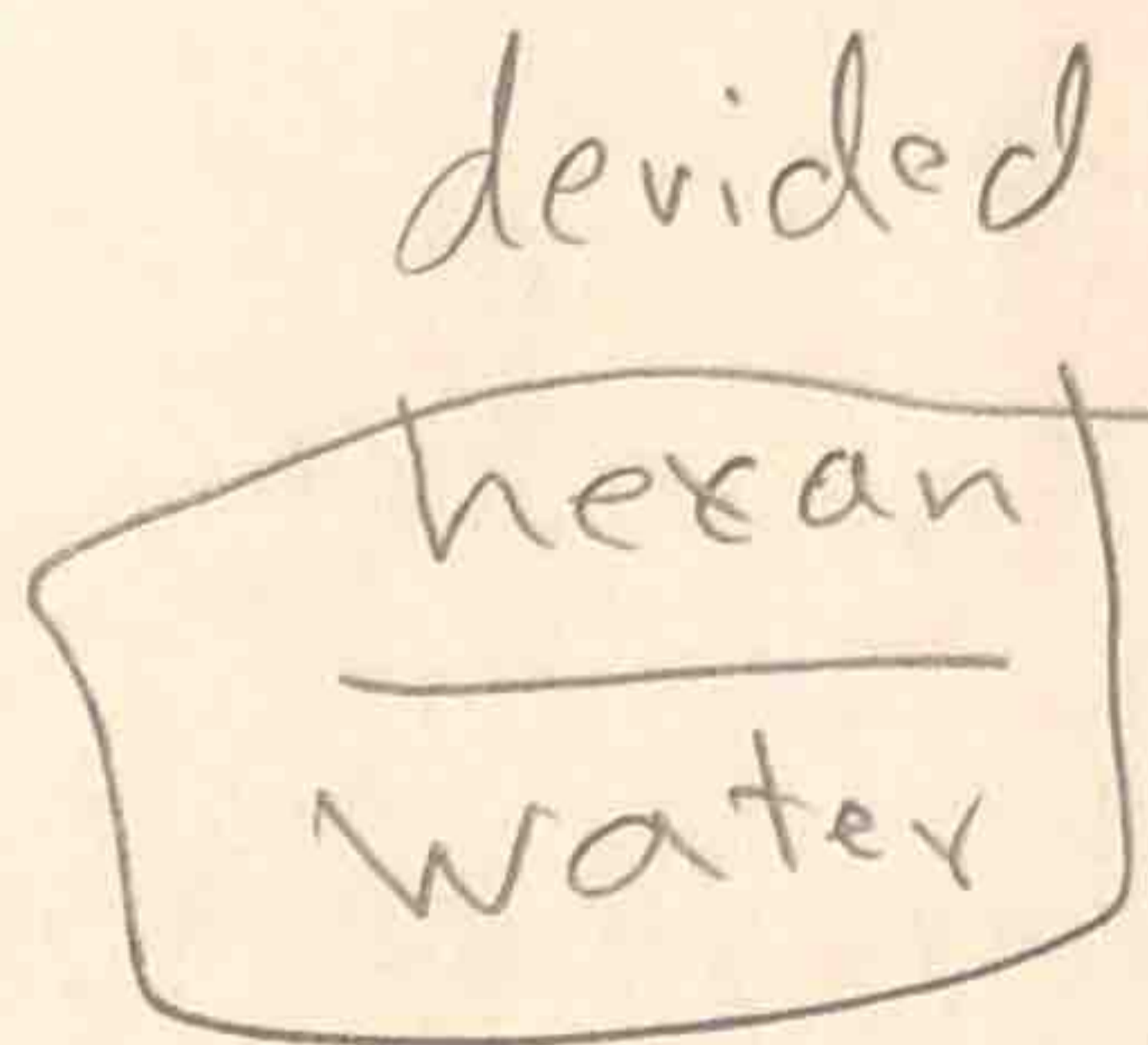
**Data Analysis**

1. Are the density values for the water and saltwater samples similar or different? Explain why you think that is.

2. Sketch a picture of what you imagine is different at the atomic level for these two liquids.

**Data Collection**

1. Rinse and dry your 50 mL beaker and obtain ~15 mL of hexane.
2. Pour ~1 mL of hexane into a test tube and add ~1 mL of water to the tube. Record your observations. Which liquid is which? Explain your reasoning. Set the tube aside.



3. Create a table in your lab notebook similar to the table in the procedure used for water. Use the same mass for the graduated cylinder.
4. Follow the same procedure as you did for collecting data for the water samples and record your mass and volume data for hexane in your new table.

**Calculations**

1. Calculate the density of each hexane sample. Also calculate the average density of your samples and record the result in your lab notebook.

$$6.3791g / 7.7667g / 8.9956g / 10.3428g$$

$$11.8161$$

**Data Analysis**

1. How does the density value for the hexane compare to that of water and saltwater?

2. Sketch your test tube with the two liquids and label the different liquids based on your density data. Explain your reasoning.

3. Find and report the actual value for the density of hexane and compare it to your experimental value. Comment on any specific sources of error you may have had.

### **Conclusions**

Discuss what concepts you learned in this lab and how they relate to material covered in lecture.