Group # _____ Name _____

Period ___ Date ___/___/___

Lab Ch 2 • Mass, Volume, & Density

Lab Partners: _____ _____ _____

Introduction: READ

Density is an important property of matter. Density can be used to identify substances. Density is defined as the quantity of matter in a given unit of volume. This relationship, expressed mathematically, is:

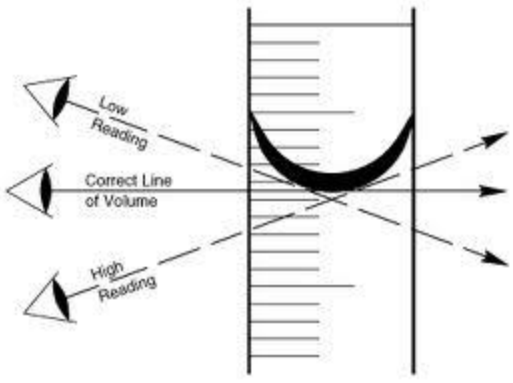
$$\boldsymbol{Density} = \frac{\boldsymbol{mass}}{\boldsymbol{volume}} \quad \text{Or} \quad \boldsymbol{D} = \frac{\boldsymbol{M}}{\boldsymbol{V}}$$

Mass and volume measurements can be made in the laboratory. Mass (in grams) can be determined by using a balance. Volumes of regularly shaped geometric solids can be determined from direct measurements of their dimensions using a ruler. For example, the volume of a rectangular solid is calculated by multiplying its length, width, and height ($V = l \cdot w \cdot h$). Volumes of solids are usually expressed in cubic centimeters (cm^3). HOWEVER, some solids are irregularly shaped objects, such as rocks, cannot be measured with rulers with any degree of accuracy. Volumes of such solids can be measured by **water displacement**. If a solid is immersed in a liquid such as water, the solid will DISPLACE a volume of water equal to its own volume.

It is necessary to use the proper units when calculating the density of a substance. Densities of liquids are usually expressed in terms of g/mL and solids are usually expressed in g/cm^3.

LAB ILLUSTRATION: BE CAREFUL WITH EQUIPMENT READINGS!!!

THE VOLUME OF A LIQUID IS COMMONLY MEASURED IN A GRADUATED CYLINDER. THE SURFACE OF THE LIQUID CURVES UPWARD WHERE IT CONTACTS THE CYLINDER WALLS. THIS CURVED SURFACE IS CALLED A **MENISCUS**. MEASUREMENTS OF VOLUME IN A GRADUATED CYLINDER ARE ALWAYS MADE BY READING THE MARK AT THE BOTTOM OF THE MENISCUS WITH THE EYE POSITIONED AT THE LEVEL OF THE LIQUID SURFACE.



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Purpose

The purpose of the lab is to find the densities of various objects by using **water displacement.**

Materials

Chemicals	Equipment
can of non-diet soft drink	10 mL and 100mL graduated cylinders
can of diet soft drink	2000mL beaker
DI water	Electronic Balance
Aluminum metal	Pipet
Sugar	3 Marbles
Salt	3 Beakers
2 Eggs	
Vegetable Oil	
Food Coloring (Red, Blue)	

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Procedure

Part 1: Density of water

1. Find the mass of a clean, dry 10mL graduated cylinder. Record the mass in **Data Table 1.**
2. Fill the cylinder with **distilled water**. Use a pipet to adjust the volume so the bottom of the meniscus is exactly 10.0mL.
3. Find and record the mass of the graduated cylinder and water.
4. Calculate and record the mass of the water.
5. Determine the density of water in the calculations section.

Part 2: Density of Vegetable Oil

1. Find the mass of a clean, dry 10mL graduated cylinder. Record the mass in **Data Table 2.**
2. Fill the cylinder with **vegetable oil**. Use a pipet to adjust the volume so the bottom of the meniscus is exactly 10.0mL.
3. Find and record the mass of the graduated cylinder and oil.
4. Calculate and record the mass of the oil.
5. Determine the density of oil in the calculations section.

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Part 3: Density of Marbles (Using Water Displacement)

1. Find the mass of 3 marbles (use a weigh boat but make sure to subtract the mas of the weigh boat). Record this mass in **Data Table 3.**
2. Pour 50.00mL of DI water into the 100mL graduated cylinder. Read and record the exact volume.
3. Place the 3 marbles GENTLY into the graduated cylinder (slide down the side of graduated cylinder).
4. Read and record the exact volume of the marbles.
5. Determine the density of marbles in the calculations section.

Part 4: Density of Aluminum (Al) Metal

1. Obtain a piece of Al metal from teacher.
2. Weigh the Al metal using the balance and record its mass to **two** places after the decimal in **Data Table 4**.
3. Fill a 100 mL graduated cylinder to the 50.0 mL mark with DI water (Be accurate and look at meniscus). Record this as the initial volume of H_2O. Record volume to one place after decimal
4. Submerge the solid carefully in the graduated cylinder (tilt the graduated cylinder at an angle to carefully slide the metal down). Read and record the NEW water level. Record volume to one place after decimal
5. Remove the solid and dry it off.

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Part 5: Density of a Can of Non-Diet Soft Drink

1. DO NOT OPEN THE CAN!
2. Pour about 1500.00mL of tap water into the 2000-mL beaker.
3. Place the can of soda GENTLY into the beaker of water, making sure that it is completely submerged.
4. Make your observations in **Data Table 5.**
5. Keep the water for the next part of experiment.

Part 6: Density of a Can of Diet Soft Drink

1. DO NOT OPEN THE CAN!
2. Using the same beaker and water from Part C, place the can of soda GENTLY into the beaker of water, making sure that it is completely submerged.
3. Make your observations in **Data Table 6**.

****When you are finished with Parts 5 & 6, please give the beaker filled with water and both cans of soda to the next lab group. LET'S CONSERVE WATER!**

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Part 7: Density of Hot vs Cold Water

1. Fill two beakers with 150 mL of water. Put 3 drops of blue food coloring in one beaker, and several drops of red in the second.
2. Add a handful of ice to the blue water.
3. TEACHER: Warm up the red beaker (using a hot plate) for couple minutes.
4. Pour some of the cold blue water into the 10 mL graduated cylinder.
5. Using a pipet, SLOWLY add red water a drop at a time and watch what happens. (This part may take a little practice—if you add the red water too fast you will force the colors to mix. Hold the pipet near the surface of the water and keep trying until you get it!)
6. Record all observations in **Data Table 7**

Part 8: Density of Salty vs Sweet

1. Use the reminder Red and Blue liquids from part 7.
2. Make sure that each red and blue beaker have about 125mL in each before you begin.
3. Add 2 teaspoons of salt to the red beaker and stir until the salt is dissolved. Add 2 teaspoons of sugar to the blue water and stir until it is dissolved.
4. Try putting an egg in each of the glasses. Does it float? Remove the eggs with a spoon.
5. Pour some of the red (salty) water into a 100mL graduated cylinder. Using a pipet, slowly add the blue (sugar) water one or two drops at a time. Record which sinks to the bottom and which floats on top.
6. Record all observations in **Data Table 8**

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Disposal/Clean Up

- Clean ALL equipment with soap, water, and brushes
- **Leave all glassware upside down so they can dry.**
- Return all materials and supplies to their proper place, as directed by your teacher.
- Clean Lab BENCH (small soap bottle and sponge) & DRY with paper towels.
- Wash hands with hand soap.
- Let me know when you are ready. **Do not get unprotected until dismissed**.

Data and Observations

(READ: Mass should have 2 numbers after decimal when using a balance and Volumes should have 1 number after decimal when using a graduated cylinder)

Data Table 1: Water

Mass of empty graduated cylinder (g)	
Mass of graduated cylinder and water (g)	
Mass of water (g)	
Volume of water (mL)	

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Data Table 2: Vegetable Oil

Mass of empty graduated cylinder (g)	
Mass of graduated cylinder and oil (g)	
Mass of oil (g)	
Volume of oil (mL)	

Data Table 3: Marbles

Mass of 3 marbles (g)	
Initial volume of water in graduated cylinder (mL)	
Final volume of water in graduated cylinder (mL)	
Volume of 3 marbles (cm^3)	

Calculate the **volume of marbles by subtraction**: Volume = Final H_2O Level – Original H_2O Level

Data Table 4: Aluminum metal

Mass of Aluminum metal (g)	
Initial volume of water in graduated cylinder (mL)	
Final volume of water in graduated cylinder (mL)	
Volume of Aluminum (cm^3)	

Calculate the **volume of metal by subtraction**: Volume = Final H_2O Level – Original H_2O Level

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Data Table 5: Can of non-diet Soft Drink

Observations after can of soda placed in beaker of water	
What does this indicate about the density of the soda compared to water? (more dense or less dense then water)	

Data Table 6: Can of diet Soft Drink

Observations after can of soda placed in beaker of water	
What does this indicate about the density of the soda compared to water? (more dense or less dense then water)	

Data Table 7: Hot and Cold

Before experiment: Make a prediction before you perform lab Does temperature change the density of water? Write down what you think will happen when you mix cold water and hot water.	
After experiment: Was your prediction right? What happened to the colored water? Did it stay in layers? If not, which layers were on the bottom and the top?	

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What does this tell you about the density of hot water compared to cold water?	

Data Table 8: Salty vs Sweet

Before experiment: Make a prediction before you perform lab Which is more dense: salt or sugar?	
After experiment: Was your prediction right? What happened to the egg in the salt water? What happened to the egg in the sugar water?	
What happened after you mixed the red salty water with the blue sugar water in the graduated cylinder?	
What does this tell you about the density of salty water vs. sugar water?	

Calculations

****Leave 5 spaces between each calculation so you have room to show work, units, and correct sig figs. BOX your answer.**

1. Calculate the density of each item in Parts 1, 2, 3, & 4. Remember $= \frac{M}{V}$.

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2. Remember that **1 mL (liquids) = 1 cm3 (solids)** , so **g/mL (liquid density) and g/cm3 (solid density)** are equivalent.

Part 1: Water

Part 2: Vegetable Oil

Part 3: Marbles

Part 4: Aluminum metal

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Post-Lab Questions (Leave about 5 lines of space to answer)

1. What measurements do you have to have in order to calculate density?

2. Did the volume of water change when an object was placed into a graduated cylinder that was half-filled with water? EXPLAIN your reasoning, but **THINK before you answer!!!**

3. When you use the terms *heavier or lighter* to compare objects with the same volume, what chemistry term are you actually comparing?

4. Why do you think the can of non-diet soft drink is more dense than the can of diet soft drink?

5. Oil and water do not mix together. According to your data, which layer would be on top and which layer would be on the bottom? Explain your reason.

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6. Determine the mass of a substance whose density is 3.5 g/mL and has a volume of 140 mL. Show your all work