CH 221 Fall 2021:
"Density" *(in class)* ***Lab***
Instructions

Note: **This is the lab for section 01 and H1 of CH 221 only.**

- *If you are taking section W1 of CH 221*, please use this link:
  http://mhchem.org/s/2b.htm

Step One:

Print this lab! You will need a printed (hard copy) version of pages I-2-3 through I-2-8 to complete this lab. If you do not turn in a printed copy of the lab, there will be a 2-point deduction.

Step Two:

Bring the printed copy of the lab with you on Wednesday, September 29. During lab in room AC 2507, you will use these sheets (with the valuable instructions!) to gather data, all of which will be recorded in the printed pages below.

Step Three:

Complete the lab work and calculations on your own, then **turn it in at the beginning of recitation to the instructor on Wednesday, October 6**. The graded lab will be returned to you the following week during recitation.

If you have any questions regarding this assignment, please email (mike.russell@mhcc.edu) the instructor! Good luck on this assignment!

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Density

Density, like color, odor, melting point, and boiling point, is a physical property of matter. Therefore, density may be used in identifying matter. Density is defined as mass per unit volume and is expressed mathematically as d = m/V (d is density, m is mass, and V is volume).

The system of measurement used universally by scientists is the metric system. In the metric system, the unit of mass is the gram (g), the unit of volume for a liquid is milliliters (mL), and the unit of volume for a solid is a cubic centimeter (cm^3). Therefore, the density of a liquid is usually expressed as grams per milliliter (g/mL), and the density of a solid is expressed as grams per cubic centimeter (g/cm^3). **[Note: 1 mL = 1 cm^3]**

When we say that gold (density = 19.7 g/cm^3) is more dense than aluminum (2.70 g/cm^3), we mean that a gold cube is heavier (has a larger mass) than an aluminum cube of the same size. For example, a block of gold that is 1 cm^3 would have a mass of 19.7 grams while the same size block of aluminum would have a mass of only 2.70 grams.

Determination of density of certain physiological liquids is often an important screening tool in medical diagnosis. For example, if the density of urine differs from normal values, this may indicate a problem with the kidneys secreting substances that should not be lost from the body. The determination of density is almost always performed as part of an urinalysis. Another example utilizing density is the determination of total body fat. Muscle is more dense than fat; therefore, by determining total body mass and volume, the muscle-to-fat ratio can be calculated.

In this experiment you will determine densities of various substances by measuring their mass with a balance and their volume with graduated cylinders. You will further determine the percent concentration of salt dissolved in water in an unknown solution graphically based on experimentally determined densities of known salt solutions.

PROCEDURE:

Part A: Determining the Density of Water

1. Record the mass of a clean and dry 10.00 mL graduated cylinder to 0.001g.
2. Fill this 10 mL graduated cylinder approximately halfway with distilled water. Record the mass of your graduated cylinder *with this volume of water in it.*
3. Calculate the mass of the water. Remember to show math setups on data sheet.
4. Read the volume of water using the bottom of the meniscus as demonstrated by your instructor. Record your volume to the hundredth decimal place value (i.e. 4.23 mL). [Remember that sig figs are the number of units known plus one estimated value]
5. Calculate the density of the water. (Remember: density = mass/volume)

Procedure continued on next page

Part B: Determining the Density of a Solution.

NOTE: The concentration of a solution is sometimes described in terms of the solution's percentage composition on a weight basis. For example, a 5% salt (NaCl) solution contains 5 g of NaCl per 100 g of solution, which corresponds to 5 g of salt per 95 g of water.

1. Clean and dry the <u>same</u> 10 mL graduated cylinder. Fill the graduated cylinder halfway with the 5% NaCl solution. Record the mass of the graduated cylinder and salt solution.
2. Calculate the mass of the salt solution. (You determined the mass of the empty graduated cylinder in part A.) (Dispose of the solution in the sink; do not return to reagent bottle!)
3. Record the volume of the solution.
4. Calculate the density of the 5% NaCl solution.
5. Repeat steps 1-4 for the 10%, 15%, and 20% NaCl solutions.
6. Obtain an unknown solution. Record its letter. Repeat steps 1-4 for the unknown solution.

Graphing:

1. Construct a graph *using pencil.* Title the graph and label the y-axis as density (g/mL). Label the x-axis as weight percent composition (%).
2. Spread the axes out so that the data covers as much of the graph as possible. You will need to decide on the size of divisions to mark your graph. Make sure that all divisions are equal. Recall that you will have five known data points from part A and part B (0% (water only), 5%, 10%, 15%, 20%). To determine your divisions of your density (y-axis) you do not need to begin at zero. *Check with your instructor before continuing*.
3. Plot your five known solutions. *Do not plot your unknown on the graph yet!*
4. Using a ruler, draw a best fit line on your graph. *Do not connect the dots!* A best fit line does not intersect all data points. It does not always go through the origin. If your data are scattered, estimate where to draw your best straight line. Roughly an equal number of points should be above the line as below the line. This approximates a mathematical technique called linear regression which judges where to draw the line to minimize the distance from each point to the line.
5. To determine your unknown % concentration, use a ruler and draw a dotted line from the calculated density of your unknown on the y-axis until its intersection with the best fit line. Mark this intersection. Next draw a dotted line from this intersection to the x-axis to determine the % weight concentration at this point on your graph. Your unknown is not necessarily the same % as one of the known solutions.

Part C: Determining the Density of a Solid.

1. Obtain a solid and record its identity.
2. Pour about 30 mL (it does not have to be exact) of distilled water into a <u>clean</u> and <u>dry</u> 50.0 mL graduated cylinder. Record the volume of water to the tenth place value (ie. 31.2 mL) by reading the bottom of the meniscus.
3. Record the mass of the graduated cylinder *and* water.
4. Carefully add the solid to the cylinder so that no water is lost. Add enough solid so that between 10-20 mL of water is displaced. Record the new volume.
5. Record the mass of the graduated cylinder, water *and* solid.
6. Calculate the mass of the solid from the above data.
7. Calculate the volume of the solid from the above data.
8. Calculate the density of the solid.
9. Determine the actual density of your solid in the <u>Handbook of Chemistry and Physics</u>.
10. Determine your percent error: |(Actual – Experimental)| / Actual x 100%

Determining the Density of Liquids & Solids

Name:

Lab Partner(s):

Part A: Density of Water **(Show calculation set up of *steps)**

1. Mass of graduated cylinder ______________
2. Mass of cylinder and water ______________
3. *Mass of water ______________
4. Volume of water ______________
5. *Density of water ______________

Part B: Density of Solution:

	5% NaCl	10% NaCl	15% NaCl	20% NaCl	Unknown
1.Mass solution & cylinder	__________	__________	__________	__________	__________
2. Mass of solution	__________	__________	__________	__________	__________
3. Volume of solution	__________	__________	__________	__________	__________
4. Density of solution	__________	__________	__________	__________	__________

6. Unknown # ________ % NaCl in Unknown _________ (determined graphically; attach graph)

Part C: Density of Solid **(show calculation set up for *steps)**

1. Solid Identity ______________
2. Volume of water ______________
3. Mass cylinder & water ______________
4. Volume of water & solid ______________
5. Mass cylinder, water and solid ______________
6. *Mass of solid ______________
7. *Volume of solid ______________
8. *Experimental density of solid ______________
9. Actual density of solid ______________
   (from the Handbook of Chemistry & Physics)
10. *Percent Error ______________

CONCLUSION: (In complete sentences, summarize the final results for parts B & C: include the unknown number, calculated density, percent error; sources of error, etc.)

POSTLAB QUESTIONS:

1. Compare a 50 mL beaker and a 50 mL graduated cylinder. Which is more precise? Why?

2. In the original Indiana Jones movie, our hero is attempting to claim a precious ancient gold relic from a poor third world country. He estimates the size of his prize and carefully adjusts the volume of sand in his bag to equal that of the gold relic. With the great dexterity that only Indiana Jones possesses, he swiftly but delicately swaps the sand for the gold. After a moment of delight, he realizes he has misjudged and the ancient tomb is not fooled. Why?

3. While panning for gold, you find a nugget that looks like gold. You find its mass to be 1.25g. You know that the density of pure gold is about 20.0 g/cm^3 and that the density of iron pyrite (fool's gold) is 5.0 g/cm^3. Determine if a cubic nugget about 0.40 cm on each side is fool's gold or pure gold. (Show all work)

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