Experiment 2: Density Report Sheet

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Part 1. Density of a Solid

Method A: Measuring the volume with a ruler

Assigned metal: (circle one) A (B) C D

Mass (measured)	21.83	g
Length (measured)	4.90	cm
Width (measured)	1.20	cm
Height (measured)	1.21	cm
Volume (calculated)	7.11	cm^3
Density (calculated)	3.23	g/cm^3

Volume Calculation:

length x width x height

$4.90 \times 1.20 \times 1.21 = 7.11$

Density Calculation:

$\frac{\text{mass}}{\text{volume}} = \text{density}$

$d = \frac{21.839}{7.1148\ cm^3} = 3.0689\ g/cm^3$

$= 3.07$

3 sig

$= 3.07\ g/cm$

Method B: Measuring the volume by displacement

Initial Volume of water (measured)	53.0	mL
Final volume of water (measured)	62.0	mL
$V_f - V_i = V_{metal}$ (calculated)	9.0	mL
Density (calculated) Use the Mass in Method A, above	2.42	g/mL

Volume Calculation:

$62.0 - 53.0 = 9.0$

Density Calculation:

$\frac{21.83}{9.0} = 2.425$

$= 2.4$

2 sig

Reflection

My metal is Aluminum with an accepted (literature) density of 2.70 g / mL.

Method B gave a value closer to the true value because:

Assigned concentration of NaCl solution: 2 % by mass

To prepare the solution, I would use 2 g NaCl and 98 g H_2O.

Density calculations for the four data points that were given in the procedure:

1)	2)
$\frac{10.27}{10.00}$ $d = 1.027$	$\frac{10.71}{10.00}$ $d = 1.071$
3)	4)
$\frac{11.10}{10.00}$ $d = 1.11$	$\frac{10.51}{10.00}$ $d = 1.051$

	X axis: (x) Concentration - % by mass	Y axis: (y) Density – g/mL	Mass of 10.00 mL Sample
1	5.00%	1.027	10.27g
2	7.50%	1.071	10.71g
3	10.00%	1.11	11.10g
4	15.00%	1.051	10.51g

density = $\frac{\text{mass}}{\text{Volume}}$

Plot the four data points from the chart above on a graph of density vs. concentration. (Give it a better name than that though!) You can print this graph paper if you don't have any. Graphs need to be plotted by hand and handwritten, like everything else in this class. Label your axes and don't forget units. Be sure that you cover an appropriate range on both the x and y axes. The range of concentration should cover from 0-15%. The range of density should cover 0.95 – 1.12 g/ml. Make a best fit STRAIGHT line, and give your graph an appropriate title.

Use points **on the line** to calculate the slope of the line. DO NOT USE DATA POINTS!

Slope Calculation: $(y_2 - y_1) / (x_2 - x_1)$

Slope:_____

Why is it important to use points to calculate the slope?
(One sentence is fine)

It is best to use points from a straight fit line because in a scatter plot of different data points, fit is used to express a relation

Density for your assigned solution using the graph to extrapolate (show extrapolation lines on the graph.) Don't forget units!

_____

Based on the graph, what is the density of a 0% by mass NaCl solution? (Look at the graph – what is the density when the concentration is 0%?)

_____

Check that your graph is complete:

- Appropriate title
- Correct variable on the correct axis
- Axes labeled with measurement and units
- Appropriate range so there is no excessive empty space in either direction
- Data points (you don't have to specify value of points on the data points)
- Best fit STRAIGHT line made with a straight edge
- Extrapolation line used to identify density of assigned solution
- (Optional but preferred) Circle the two points on the line used to determine slope

This is essentially what all graphs will be graded against for this class, and what will be looked for when graphing in future classes, so keep this list handy when you are making graphs. Graphs need to be made by hand, and are worth a good deal of points towards the experiment.

Once your graph is complete and your report sheets are completely filled out, turn all pages into a pdf with the graph as the last page.

Learning Goals

After completing this virtual lab, students will be able to:

- Measure the volume of a rectangular prism of metal with both a ruler and by the volume displacement method.
- Use a balance to measure the mass of objects.
- Calculate an experimental density for an object from the measured mass and volume.

References

- *Introductory Chemistry* (Tro, 6th Edn): Section 2.10 -OR- the equivalent section in ChemLibre
- Video Lesson on Density
- Measurement reference.pdf (**<-- super helpful**)
- Refer to Exp: Measurement for more measurement reference.

Lab Activities:

- Download and print the Density Report Sheets
- Follow the instructions below to complete parts 1 and 2 for your lab report
- Upload the completed report sheets and graph into Canvas by Sunday night at 11:59 PM

Instructions:

- Part 1:
  - Find your metal for Part 1 by checking the Density Assignments
  - Complete Part 1: Method A by following the directions for Method A and referencing the pictures below for your assigned metal.
  - Complete Part 1: Method B by following the directions for Method B and referencing the video below for your assigned metal.
  - Your assigned metal is for Method A and B. Only do the work for your assigned metal!!
  - Be sure to read all measuring tools and state the measurements in your data sheet to the correct level of precision.
  - Pay attention to sig figs in your calculations.
  - Record the data, do the calculations, and answer the questions on the report sheets.

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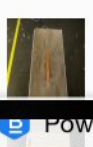
Part 1: Density of a Solid

Method A: Measuring the volume with a ruler

Use the pictures in the chart below to record the mass, length, width and height of your assigned metal rectangular prism.

Metal	Mass	length	width	height
				

Method B: Measuring the volume by volume displacement

You will be analyzing the same object, but this time you will measure the volume by volume displacement instead of using a ruler to measure its dimensions. You should record the mass of your object from the pictures in Method A, above. For the volumes, use the videos below. The initial volume of water is the measurement of water in the graduated cylinder **before** the metal is added. The final volume is the volume of water **after** the object is added. The volume of the object is the difference between the final and initial volumes of water.

Calculate the density of the object based on the data obtained in "Method B" (volume displacement). Determine what the actual metal is that you used for parts A and B, based on its color. The possible metals are:

- Brass with a density of 8.52 g/mL
- Copper with a density of 8.96 g/mL
- Iron with a density of 7.87 g/mL
- Aluminum with a density of 2.70 g/mL

Compare the two methods: Method A (measuring the volume with a ruler) to Method B (measure the volume by displacement in a graduated cylinder). Which density is closer to the true value? Why do you think that is?

Metal	Video of Volume being Measured by Volume Displacement
A	https://youtu.be/lP3xBc562J4
B	https://youtu.be/8qXe046iXSY
C	https://youtu.be/V3khFX9iqTM
D	https://youtu.be/URqCUhBb_Xo

- Part 2:
  - Find the % by mass NaCl solution assigned to you by checking the Density Assignments
  - YOU ARE NOT MAKING A NaCl SOLUTION. YOU ARE JUST DOING CALCULATIONS AND MAKING A GRAPH FROM THE DATA.
  - Be sure to read all instructions below and in the report sheets to get Part 2 completed.
  - Use the data below to complete Part 2 in the report sheets.

Part 2. Density of Mixtures of Salt and Water ("Saltwater

Metal	Video of Volume being Measured by Volume Displacement
A	https://youtu.be/lP3xBc562J4
B	https://youtu.be/8qXe046iXSY
C	https://youtu.be/V3khFX9iqTM
D	https://youtu.be/URqCUhBb_Xo

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Part 2. Density of Mixtures of Salt and Water ("Saltwater solutions")

Each student has been assigned a sodium chloride (NaCl) solution of a certain % by mass concentration. Concentrations of percent by mass are out of a total mass of 100 g. For example: 2.5 % NaCl would be 2.5 g NaCl, 97.5 g H_2O.

Watch this video for how I made the example solution, obtained a 10.00 mL sample, and measured its mass:

Video

Calculate the masses of NaCl and water needed to make your assigned concentration. Then, use the data below to calculate the density of the four solutions given.

Concentration (% by mass)	Mass of the 10.00 mL Sample
5.00%	10.27 g
10.00%	10.71 g
15.00%	11.10 g
7.50%	10.51 g

Once you've calculated the densities of these solutions, make a table of your data and use it make a graph of Density vs Concentration. It should have 4 data points on it.

Draw a best fit line through the data

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7.50%	10.51 g

Once you've calculated the densities of these solutions, make a table of your data and use it make a graph of Density vs Concentration. It should have 4 data points on it.

Draw a best fit line through the data points and calculate the slope of the line using two points on the line. DO NOT USE DATA POINTS FOR THE SLOPE CALCULATION!

To calculate the slope, m: $m = (y_2 \text{ â } y_1) / (x_2 \text{ â } x_1)$

Use the straight line you drew on the graph and extrapolate to determine the density of the solution you were assigned.