Chemistry 140

Please have the following pages ready **before** class on Monday, October 2. Note that the different parts will be standard divisions in **all** lab writeups. For this particular writeup, please write an **abstract** and **paper-clip** it to the front of your individual writeup. The abstract and the carbon-copy pages of the write-up is due in class on **Monday, October 9.**

And this is what your lab notebook should look like:

Your name, your partner's name, date of experiment

Lab 1: Precision and accuracy in glassware, and the determination of density

Part 1. Purpose

Copy the following into your notebook.

Section 1 — By calculating the density of a known substance (water), determine the relative precision and accuracy of different glassware items.

Section 2 — Determine the density of a salt water solution using the most precise and accurate piece of glassware determined in section 1

Part 2. Materials and methods

Copy (or sketch) the following into your notebook.

Equipment: 100 mL beaker, 10 mL graduated cylinder, 10 mL pipet with pipet suction device; also, a large beaker to provide a distilled water reservoir

Chemicals: Distlled water, colored saltwater solutions A, B and C

Sketch the setup as you are using it and label the various pieces of equipment.

Part 3. Procedure

Copy the following into your notebook.

Section 1 — Choosing the most precise and accurate instrument to measure density

1. Weigh a **dry** 100 mL beaker, a 10 mL graduated cylinder and a 10 mL pipet cylinder and record the mass for each on the data sheet. Recall that a trailing zero is a significant figure, and should be written down!

2. Obtain a fair amount of distilled water (from the carboy at the front of the classroom) and measure its temperature. Remember to record this number to the tenths of degrees.

3. To the best of your abilities, put 10 mL of water in each glassware item. Record the volume for each one, remembering that you should estimate one place past the markings.

4. Weigh and record the mass for each item. **Be careful not to spill!**

5. Do this three times for each piece of glassware, taking care to dry (as best as your can) the glassware in between trials.

6. Consult a reference book, such as the CRC Handbook to determine the density of water at your observed temperature.

Section 2 — Determination of saltwater density

1. Obtain one of the colored solutions and record the letter of the solution.

2. Using the most precise and accurate piece of glassware found in section 1, measure the density of the saltwater. Perform five independent trials, remembering to dry the glassware as much as possible between trials. You may use the taring (zeroing) function of the electronic balance for these measurements.

3. As a qualitative check of your result, obtain a clean dry 100 mL beaker and put about 30 mL of distilled water in it. Using the pipet, carefully trickle 10 mL of the colored saltwater solution down the side of the beaker. Note where the colored solution ends up.

Waste disposal — All solutions can be poured down the sink.

Part 4. Original data

For the sake of your being able to write (and make mistakes and cross-outs), you should make the squares in these tables larger when you copy them into your lab book.

Table 1: Different pieces of glassware and the density of water

Temperature of distilled water ______________ °C

Trial 1:

Glassware	Beaker	Graduated cylinder	Pipet
Dry mass (g)			
Mass with water (g)			
Mass of water (g)			
Volume of water (mL)			
Density of water (g/mL)			

Trial 2 and Trial 3 tables should look similar.

Table 2: Saltwater density determination

Colored saltwater solution letter ______

Trial number	#1	#2	#3	#4	#5

mass of solution (g)					
volume of solution (mL)					
density of solution (mL)					

Qualitative test of the density result: Draw a sketch of the beaker after the colored saltwater has been added.

Part 5. Calculated results

Section 1

Calculate the average (mean) and the standard deviation of the **water's density** for each of the three pieces of glassware.

Calculate the percentage error from the value of the density you looked up in the reference. The formula for % error is:

$$\%\ error = \left| \frac{measured\ value - reference\ value}{reference\ value} \right| \times 100\%$$

Report the above in table form:

Glassware	Beaker	Graduated cylinder	Pipet
Mean density ± standard deviation (g/mL)			
Percent error from the reference value of density			

State which piece of glassware you will use for section 2.

Section 2

Calculate the mean and standard deviation of the density of the saltwater you used.

Part 6. Group results

Obtain the raw data for all groups' saltwater densities, and also the letter of the saltwater solution that each group used. Calculate the mean and standard deviation for each saltwater solution (i.e., Density of saltwater solution A = "1.033 ± 0.034 g/mL" etc.).

Part 7. Questions

1. Though the pipet may be a very precise instrument, what **practical limitation** does the pipet inherently contain?

2. Was the standard deviation you calculated in section 2 for the saltwater larger, smaller or the same as the standard deviation you calculated for the same piece of glassware in section 1? Assuming you made no significant technique errors, with a

larger number of trials, what should happen to the standard deviation for *any* piece of glassware?

3. What is a data **outlier**? Looking over the various groups' data, were there any outliers? Without doing any heavy recalculations, if outliers were removed from the data set, how would the standard deviation be affected?

4. Are saltwater solutions A, B and C clearly distinguishable (in other words, are they different salinities) from each other, according to your calculations (recall that their ranges must **not** overlap). If not, state which solutions might be the same. Finally, give the **order**, from least dense to most dense, of A, B and C.

5. Suppose the outside of the glassware is not completely dry when it is weighed with the water in it, but it *is* dry when weighed at other times. Explain how that error will affect your density (for instance, will the density be higher or lower than it should be?). Would this be an example of random or systematic error?

Part 8. Conclusion

The conclusion should be a *brief* recap of your results and sources of error (confidence you have in your results).

First sentence: "We determined that the ____________________ was the piece of glassware we would use for the density determination because ____________________."

Next couple of sentences: Cite a couple of numbers to back up your claim in the first sentence.

Next sentence: "Using the _________________, we calculated the density of saltwater solution ___ was __________ ± __________ g/mL."

Last sentences: Was this technique good enough to distinguish between the saltwater solutions, as a class? How confident are you in this result? In other words, was your (or the class's) technique and result good enough that you would feel this procedure could be given to the next group of students without modification? If you do not feel this way, suggest how the procedure could be modified to prevent some of the problems you may have encountered.

Abstract

An **abstract** is a summary of a larger report or manuscript. In the sciences, it is used to index millions of articles; for instance, the Chemical Abstracts Service (CAS) indexes various articles by the chemical formula of the compound(s) used, so it is crucial that one writes the chemical names in the abstract of the journal article.

For this class, I am looking for a short (less than 100 word) summary of the major result(s) of your experiment, and the method by which you achieved this result.

Specifically, for this experiment, use “We determined the density of saltwater solution ___ was ____________ ± __________ g/mL, through the use of ________________ and an electronic balance. The precision of these instruments (were/were not) sufficient to distinguish the densities of the different saltwater solutions used.

Note that the abstract really does cut to the chase and is even shorter than the conclusion.

Also note that, for lab #2, I will not supply “the fill in the blanks” wording!