

The Floating Egg Problem¹

For many years soap was made at home from a variety of recipes. Animal fat, usually from cattle (also called tallow) was cooked with a lye solution. Lye, though it was mostly simple sodium hydroxide, could not be made from purified chemicals, as we do now. Instead, the solution was obtained from ashes and water. The ashes were treated with hot water, and then the mixture was filtered to obtain a solution.

But before this could be used in soap making, one had to check the concentration of the lye solution in order for it to be effective. One simple test was to try to float a raw egg in the solution. If the egg sank, the concentration of the lye in the solution was too low. If the egg floated too high, the concentration of the solution was too great, and water was added before adding the fat. **To “just float” in this case means to make the top of the egg just touch the top of the solution, without any significant amount of the egg protruding above the surface of the solution.”**²

The objective of this lab is to obtain a solution that “just floats” an egg and determine its density. Because lye is caustic and corrosive, sodium chloride (table salt) will be substituted in this lab. The solutions are concentrated enough to be an eye hazard so safety goggles must be worn.

In this lab you will use a process of scientific inquiry. Gaining first-hand knowledge of the processes of scientific inquiry, problem solving, and critical thinking is of equal or greater importance than knowing the “correct” answers to problems. Often, problems do not have a single correct answer; there may be several possible solutions. So, understanding the process of science allows us the ability to address a variety of problems now and in the future. The following problem is also designed to further exercise your procedure writing skills, data collecting and reporting skills. You will also be expected to practice measurements and reporting the correct number of significant figures based on your methods and technique (glassware used, measurement skills, etc.)

Use of precision glassware

Chemists use special volumetric glassware in the chemistry laboratory (rather than the ordinary beakers and flasks) when they need high-precision measurements of the volumes of liquids. Understanding the proper use and limitations of such glassware is important in achieving reliable results. Experimental technique and the inherent accuracy of the glassware both affect experimental results. One of your personal goals for this course is to develop sound experimental techniques.

¹ Adapted from “Working with Chemistry A Laboratory Inquiry Program” by Donald J. Wink, Sharon Fetzer Gislason and Julie Ellefson Kuehn; W.H. Freeman and Company New York, 2000.

² A youtube video from “pioneercookery” shows the process of making soap from wood ash and lard:
<http://www.youtube.com/watch?v=ZuzCD7EP1ZM>

Practical Applications of density today: How oil is changed in your car, or the detection of anemia (iron deficiency) in your blood is based on less dense substances floating on more dense substances.

Follow your lab notebook guidelines for this lab.

A very important part of science relies on the ability of scientists to reproduce their results. Thus it is required that scientists maintain complete and accurate records of their work. This includes every piece of data (with units!), sketches of equipment or apparatuses used, and observations during the experiments.

Organizing your data: Creating data tables

Advance preparation and understanding of the lab is important in knowing what data to collect. Remember to keep in mind that when you weigh a substance, you may not tare the mass of the container. **Taring** the container means that you set the container on the balance and “zero” it. This means the balance will automatically subtract the mass of the container in its reading(s). Instead, you will need to record a mass for the container, the mass of the substance in the container, and determine the mass of the substance by mass difference. Thinking ahead about these details will help you construct a data table.

mass of 10-mL graduated cylinder (empty)	25.067-g
mass of 10-mL graduated cylinder + unknown liquid	28.076-g
mass of unknown liquid	
volume of unknown liquid	5.80 mL 5.75 mL
density of unknown liquid	

In the table above, the student provided a clear description for each measurement, along with the units next to each number. The data above was filled in during lab. Notice that when a mistake is made, simply draw one clear line through it and write the correction next to the mistake (as above, for the volume of unknown liquid).

There are two entries in the data table without any values assigned. These are important values that need to be calculated at a later stage in this particular experiment. Can you fill in the blanks based on the data recorded?

Keep in mind that the data table should be organized in a logical way. It would be confusing to put the density of the unknown liquid in the table first, since it requires the mass and volume of the unknown liquid. Following a logical order will minimize confusion, especially for your instructor!

How to report data

All data should be **recorded** in your notebook, but only some data (usually very minimal) is **reported**, or submitted. For example, the **recorded** data may include: the masses of the cylinders, the unknown liquid, the volumes and the calculated density (the final result). However, **only the most relevant data should be reported in a concise**

manner. For example, *report* your measured masses and volumes of the solutions in a summary data table, but do not report your masses of glassware in the summary.

How to record observations

Make sure you record what you see initially and whatever changes that may occur. Especially of importance are chemical changes, such as color changes or the formation of a gas or solid. It is also a good idea to make drawings or sketches of a setup or an apparatus with which you are not familiar. You should also record notes about your progress and whether you've made any modifications to the experiment.

Consider your observations to be notes that you are taking during your experiment—notes that may be very useful for you in repeating your experiment or in gaining understanding about the experiment.

Special notes on data collection for this lab:

- ❖ Record all measurements to an appropriate number of significant figures, as based on your measurement device.
- ❖ Record the units on every measurement! The units may seem obvious to you, but you must not leave any ambiguities.
- ❖ Important observations and notes (such as chemical changes, or changes to the procedure) should be recorded clearly and concisely.
- ❖ Never record data on scratch paper or any other piece of paper that requires the data to be transferred to the handout. Record all data directly onto the handout.

General rule of thumb: Always write and organize your work so someone else will be able to repeat your directions without any confusion or uncertainty.

Experimental Section:

There is no prescribed procedure for this lab. Scientific inquiry means you can design your own methods. The only limitation are the materials provided and your creativity and scientific skills!

Materials Available: Deionized water, Lab Station Supplies, Balances, Eggs, Sodium chloride (salt), Volumetric flasks, Micropipetters

Before you begin, complete the following with your lab partner and write it in your lab notebook:

1. Rephrase your task in this experiment. What are you trying to accomplish? What data do you need to report at the end of the experiment (and in what units)?
2. Formulate a procedure for this experiment. Write down your procedure clearly enough that other people will be able to reproduce your experiment. Be very specific in which equipment you intend to use for your measurements (e.g. 50-mL beaker or 10-mL graduated cylinder, etc...) as this will affect your precision.
3. When you are ready, get started on collecting data. Record data as you go (you will write it neatly in a data table at the end of the lab period). **NEVER USE SCRAP PAPER** to record your data! Always record data directly in your notebook, and use PEN.
4. Show your calculations in your notebook and summarize your results. Collect results from at least three other lab teams and record those values in your notebook.

Warning: Do not discard salt solution (that floated the egg) until instructed to do so!!!

Disposal: If you have unused NaCl left over, place it in the beaker labeled “excess NaCl”. NaCl solutions can go down the sink with plenty of water. Return the eggs to your instructor (unless they are cracked – toss them in the trash).

Report Sheets
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Name_____ Date_____
Lab partner_____ Section_____

Turn in these pages only.

Always use PEN to record data. Record units for all measurements!

If you make mistakes, do not use white-out.

1. Summarize your procedure in the space below using complete sentences. Do not provide a list of instructions. Try to be concise but provide enough detail that another student could reproduce your experiment. It should be no more than 1-2 short paragraphs.

2. Create a summary data table for the data you collected in this experiment. If you have collected a page of data (a lot of data points) please select only the most important data that lead to the final calculated result (density). Be concise.

You will be graded on whether you include units, how legible this table is, the logical layout of the table and the completeness of the data collected.

Follow-up Questions

1. Calculate the density of the solution in which the egg “just” floated. **Show your work** below and report the density with the correct number of significant figures (based on the measuring devices you used).

Density = _____ g / mL

2. a) How does this compare to the value determined by other groups? Find at least three other groups and record their values below.

b) For the values you report above, calculate the average density value and standard deviation.

c) What three factors do you think MOST contributed to the variation in density values in the class?

3. It is possible to accomplish this lab with a density value reported to 4 significant figures. If your density value did not have at least 4 significant figures, how might you change your procedure in order to achieve this precision?

Pre-Lab Assignment—To be completed BEFORE lab!

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Understanding the previous experiment on measurement and the use of significant figures and uncertainty in measurements in general will help you answer the last two questions.

1. Prepare your lab notebook for this lab, following the lab notebook guidelines. For the procedure section, draft a procedure that could work for this lab. You will have time to discuss and refine this procedure with your lab partner during the lab.

2. You would expect the density of the solution that “just floats” an egg to be (choose one):

(a) zero (b) less than 1 gram/mL (c) exactly 1 gram/mL (d) greater than 1 gram/mL

Explain briefly.

3. An *intrinsic* property is one that is independent on the amount of substance present. An *extrinsic* property depends on the amount of substance present. Is density an intrinsic or extrinsic property? Explain briefly.

4. The density of a liquid is determined using a 50.00 mL volumetric flask (which has an uncertainty of ± 0.01 mL). Would the reported density value be better, worse, or the same if a 600-mL beaker (which has an uncertainty of ± 10 mL) was used for the volume measurement? Explain how the reported values would be different and which would be preferred.

5. If you have a choice between measuring volume (to determine density) using a beaker, graduated cylinder, graduated pipettes, which would you use and why?

Questions: How to record and organize your data

6. What is the appropriate method for correcting mistakes in your notebook, which are written in ink? Can you use white-out? Why or why not?

7. Why should you label your measurements with units?

8. Suppose you are doing an experiment which requires that you mix each reagent A, B, and C with reagents 1, 2, and 3 for a total of nine experiments. Construct a condensed and concise data table for this set of experiments.

9. Suppose you weigh a flask that is 50.553 grams. After putting 5.00 mL of a liquid into it, you weigh it again and it is 52.663 grams. Create a data table for these data and determine the density of the liquid using the data in your table.

10. Which data (from above) would be “reported” as opposed to “recorded”?