# Week 1 Laboratory – Safety and Laboratory Measurements & Procedures

Date: Tuesday, August 27, 2019
Topic: Lab Safety, Measurements & Procedures

Assignments (Individual but you may work together with classmates):
1. **In class**—Safety Quiz, measurement of masses and volumes, Gee, Roy, and Biv's micropipette challenge
2. Memo with data from today's lab: **Due Date: Tuesday, September 3, before lab to Prof. Sills. All labs should be submitted as hard copies.**

## *OBJECTIVES*
1. Become oriented to the lab, in particular with respect to safety issues.
2. Measure masses and volumes, and calculate the accuracy and precision of pipetting. You will need to measure masses and volumes throughout the semester.
3. Test your pipetting skills by creating a color spectrum.

## 1. **Laboratory Safety**

1. Lab safety video.
2. Location of lab safety equipment and information in the Environmental Lab.
3. Read lab safety document and do quiz. You may work together.
4. Deliverable (in lab before you leave): Safety Quiz.

## 2. **Measurement of Masses and Volumes**

Many laboratory procedures require preparation of chemical solutions. Most chemical solutions are prepared on the basis of mass of solute (chemical) per volume of solution (grams per liter or moles per liter). To prepare chemical solutions, we need to be able to accurately measure both mass and volume.

### *Experimental Methods*

*Mass Measurements*
Mass can be accurately measured with an electronic analytical balance. Perhaps because balances are so easy to use it is easy to forget that they should be calibrated on a regular basis. In our lab, the lab director, Monica Hoover, calibrates the balances regularly.

Dry chemicals and liquids can be weighed in disposable plastic "weighing boats" or other suitable containers. It is often desirable to subtract the weight of the container in which the chemical is being weighed. The weight of the chemical can be obtained either by weighing the container first and then subtracting, or by "zeroing" (or "taring") the balance with the container on the balance.

*Pipette Technique: precision and accuracy*

1) Use Figure 1 to estimate the expected mass of 990 µL of distilled water (at room temperature—check the thermometer), and record this value in a spreadsheet or lab notebook.

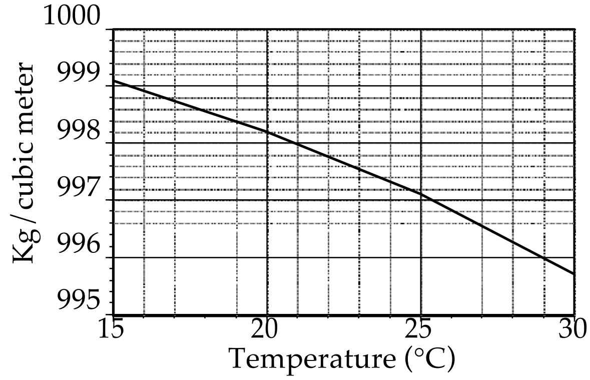


**Figure 1. Density of water vs. temperature.**

2) Use a 100–1000 µL or a 1–5mL digital pipette to transfer 990 µL of distilled water (that has been equilibrated to room temperature overnight) to a tared weighing boat on one of the balances in the lab. Record the mass of the water. Repeat this process 5 times, so you have 5 replicates. Calculate the mean, $\bar{x}$, (which you should define as Eq. 1), standard deviation (which you should define Eq. 2), and coefficient of variation, $cv = s/\bar{x}$, for your measurements. You may use built-in Excel functions for at least two of these calculations. The coefficient of variation (c.v.) is a good measure of the precision of your technique. For this test a c.v. < 3% should be achievable.

   Repeat this entire process (i.e., repeat five pipetting trials) until the precision of your pipetting is less than 3%. Record all measurements in a nicely formatted table (see Table 1 as an example of a properly formatted table). In addition, report the mean, standard deviation, and cv as text.

Equation 1:

Equation 2:

Table 1. Mass of 990 micro liter of water.

| *Sample number* | *1* | *2* | *3* |
|---|---|---|---|
| *Measured Mass (g)* | 0.980 | 0.990 | 0.987 |
| *Expected Mass (g)* | 0.990 | 0.990 | 0.990 |

3) Compare the mean mass of water (that you measured) with the expected value (from Fig.1) to determine the accuracy of your measurements. If the error is more than 5%, place colored lab tape on the pipette and record the error (write on the tape, not on the pipette) with a Sharpie. Assume that the mass is correct and that errors are associated with the pipettors or, more likely, your pipetting technique.
4) To test your pipetting technique, conduct Gee, Roy, and Biv's Micropipette Challenge (see attached handout), and show me your results before you leave lab.

## 3. Deliverables:

A memo with today's data analysis for *Pipetting Technique* is due as a hard copy before lab on September 3. Submit Safety Quiz before you leave.

# Gee, Roy and Biv's Micropipette Challenge

Laboratory science often involves working with very small volumes of liquid - frequently millionths of liters are used. One millionth of a liter is equal to one microliter, abbreviated 1 μL.

1 L = 1,000 mL = 1,000,000 μL

It would be very difficult to measure such small volumes without a very accurate and precise instrument. The instrument most often used by scientists to measure microliters is called a micropipette.

Gee, Roy, and Biv are having problems with their science lab. Their teacher is asking them to construct a model of a spectrum, but none of them have a clue as to what a spectrum is or how to make one. Use the following table and the directions that follow to help them by constructing your own spectrum. It is important that you follow the directions and use the best pipette technique possible.

**Setting up your tubes:**

1. Label the six test tubes at your station, 1 -6.

**Constructing Roy's Spectrum - make sure you record in the table below any volume added to or removed from a tube:**

2. Put 1900 μl of red liquid into test tube number 1.
3. Put 2200 μl of yellow liquid into test tube number 3.
4. Put 2500 μl of blue liquid into test tube number 5.
5. Take 400 μl from test tube number 1 and put it into test tube number 2.
6. Take 400 μl from test tube number 1 and put it into test tube number 6.
7. Take 400 μl from test tube number 3 and put it into test tube number 4.
8. Take 700 μl from test tube number 3 and put it into test tube number 2.
9. Take 700 μl from test tube number 5 and put it into test tube number 4.
10. Take 700 μl from test tube number 5 and put it into test tube number 6.

**Crunching the numbers:**

11. Use your data table to find the total volume in each tube and record your answer in the table.
12. Use the conversion factor to convert your units from microliters to milliliters.
13. What is the spectrum that you created?

**Write in the table every time liquid is added or removed from a tube:**

| Test Tube Number | Amount added or subtracted from tube (μL) | Amount added or subtracted from tube (μL) | Amount added or subtracted from tube (μL) | Total Volume in microliters (μL) | Total Volume in milliliters (mL) | Color of liquid in tube |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | | | | |

RUBRIC

| | | | |
|---|---|---|---|
| **Memo Header** | **10 9 8** | **7 6 5 4** | **3 2 1 0** |
| Document is formatted as a memo (**10 pts**) | Meets all criteria at high level | Meets some criteria; uneven | Meets few criteria |
| **Data analysis** | **10 9 8** | **7 6 5 4** | **3 2 1 0** |
| Description of how data were collected and processed is clear and concise, may include equations. Data are processed correctly. (**20 pts**) | Meets all criteria at high level | Meets some criteria; uneven | Meets few criteria |
| **Presentation of data (table and/or text)** | **10 9 8** | **7 6 5 4** | **3 2 1 0** |
| Five data points, mean, std dev, and cv reported. Appropriate Sig Figs. No irrelevant or redundant data included. (**20 pts**) | Meets all criteria at high level | Meets some criteria; uneven | Meets few criteria |
| **Formatting of tables** | **10 9 8** | **7 6 5 4** | **3 2 1 0** |
| Choice of presenting data in a table or figure enhances reader's understanding. All tables include correctly formatted captions and units. (**20 pts**) | Meets all criteria at high level | Meets some criteria; uneven | Meets few criteria |
| **Discussion** | **10 9 8** | **7 6 5 4** | **3 2 1 0** |
| Accuracy and precision are discussed correctly (**20 pts**) | Meets all criteria at high level | Meets some criteria; uneven | Meets few criteria |
| **Readability** | **10 9 8** | **7 6 5 4** | **3 2 1 0** |
| Text is clear, concise, and coherent. (**10 pts**). | Meets all criteria at high level | Meets some criteria; uneven | Meets few criteria |