Experiment One – Laboratory Balance: Mass Calculations

Objective

The balance is used almost every day in the chemistry lab, understanding the proper use and care for the balance is essential for any chemist. The purpose of this laboratory exercise is to demonstrate method for measuring a mass throughout the course.

Introduction

The accurate determination of *mass* is one of the most fundamental techniques for students of experimental chemistry. **Mass** is a direct measure of the *amount of matter* in a sample of substance; that is, the mass of a sample is a direct indication of the number of atoms or molecules of reactant present, it is essential that the mass of reactant used in a process be accurately known.

There are various types of balances available in the typical general chemistry laboratory. Such balances differ in their construction, appearance, operation, and in the level of precision they permit in mass determinations. The two balances present in most labs are the top loading balance, shown below in Figure 1.1, and an analytical balance is similar with more decimal places to show increased precision The top loading balance is the everyday quick measurement balance. An analytical balance provides much higher precision and is typically used for smaller quantities of material, because it is much more sensitive, it is also more fragile.

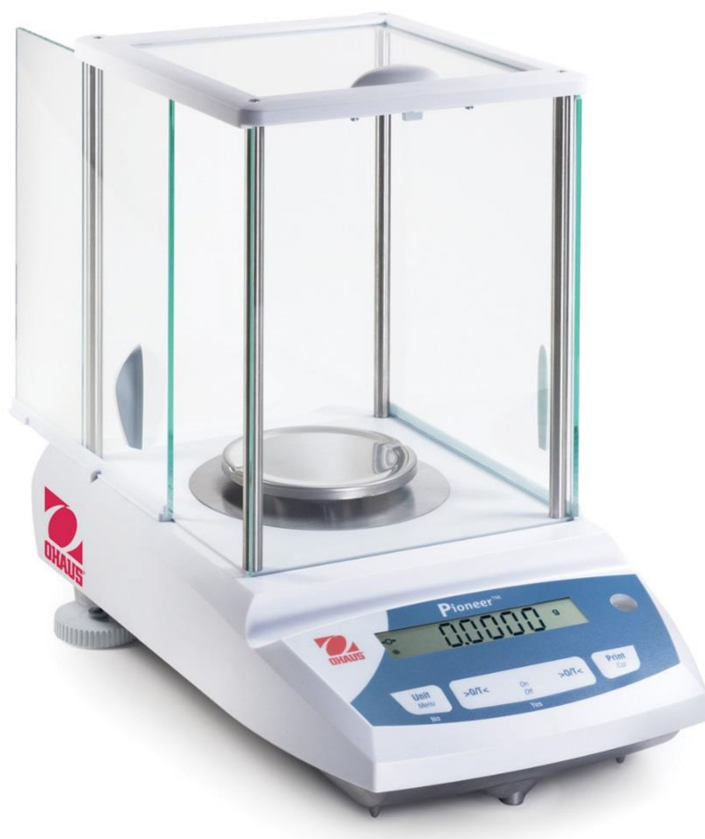


Figure 1.1 – Top loading balance.

There are some general points to keep in mind when using any laboratory balance:

1. Always make sure the balances gives a reading of 0.000 grams when nothing is present on the balance pan. Press the "tare" or "zero/0" button if it does not. If the balance will not zero, there may be an issue with that balance and you should try another one.
2. All balances, but especially electrical/electronic balances, are damaged by moisture. DO NOT pour liquids in the immediate vicinity of the balance. Clean up any spills immediately from the balance area. Any remaining moisture on the weigh plate should also be wiped clean before heading back to your lab desk.
3. No chemical should ever be weighted directly on the pan of the balance. Ideally reagents should be weighted directly into a beaker or flask. There should ALWAYS be a barrier between your substance and the balance. Plastic weighing boats may also be used if several reagents are required for an experiment. Pieces of filter paper or weighing paper should ordinarily not be used for weighing chemicals.
4. Procedures throughout the semester are generally written as "weigh 0.5 grams of substance (to the nearest milligram." This does not mean exactly to 0.500 grams of substance. Rather, the statement means to obtain an amount of substance between 0.450 and 0.550 grams, but to record the *actual amount of substance taken* (example – You're asked to measure out 0.500g of material to the nearest milligram. As long as you record your result the experiment can proceed as normal with that number, so weighing out 0.496 grams is okay *as long as the value is recorded in your results*). Unless a procedure states explicitly to weigh out an exact amount (ex. "weigh out exactly 5.00 grams of NaCl"), you should not waste time trying to obtain an exact amount. However, **always record ALL of the decimal places given on the balance.** (If the balance reads 0.4535, do not round that to 0.45 grams. It should be written as seen on the balance. *You're given the numbers, use them all*.)
5. For accurate mass determinations, the object to be weighed must be at room temperature. If a hot or warm object is placed on the pan of the balance, such an object causes the air around it to become heated. Warm air rises, and the motion of such warm air may be detected by the balance, giving a mass that is lower than expected.
6. For many types of balances, there are likely to be small errors in the absolute masses of objects determined with the balance, particularly if the balance has not been properly calibrated or has been abused. For this reason, most mass determinations in the laboratory should be performed by the difference method:
    1) An empty container is weighed on the balance
    2) Then the chemical or object whose mass is to be determined is added to the container
    3) The container now containing the chemical/object is weighed on the balance
    4) The difference between those two is determined.

    mass of chemical = mass of container w/chemical – mass of empty container

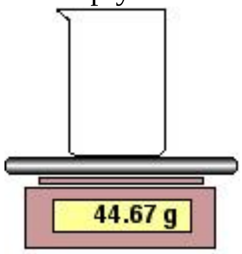
    The same balance should be used throughout the procedure to avoid any calibration errors.

Calculations

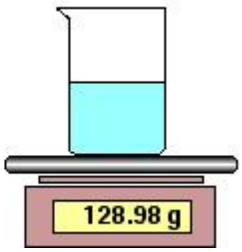
Difference method

The difference method, explained above, is the proper way to measure a mass in the laboratory. This method will be the method used every time we determine a mass throughout the semester. The difference method helps avoid non-calibrated balances and is simply subtracting the weight of the empty container for the chemical of interest. Difference Method:

1) An empty container is weighed on the balance



2) Then the chemical or object whose mass is to be determined is added to the container
3) The container now containing the chemical/object is weighed on the balance



4) The difference between those two is determined.

mass of container w/ chemical – mass of empty container = mass of chemical

128.98 g – 44.67 g = mass of chemical

84.31 g = mass of chemical

% error

Percentage error is a way to check your experimental technique as well as the equipment used, against what is accepted by the science community. The percent error is based on the experimentally determined values obtained by a student in the lab, against the literature values accepted by science. If percent error is high it's an indication that there is an experimental issue: human error as a result of poor technique or flawed equipment providing inaccurate measurements; most often it's a combination of the two.

$$\boxed{\%\ error = \frac{experimental\ value - literature\ value}{literature\ value} x100}$$

Procedure

Record all data and observations in the space provided below, please write legibly.

Materials/Reagents Required

- **Two labeled objects provided by instructor**
- **Two beakers (150ml beaker and 250ml beaker)**

Part I (1st Balance)

150ml Beaker + First Object

1. Choose a balance to do all of your measurements for Part I (must be the same balance for all measurements)
2. Weigh empty 150ml beaker and record the value in your Results/Observations section.
3. Record the ID number of your first object in your Results/Observations section.
4. Place the object into the 150ml beaker and weigh the sample, record this value in your Results/Observations section.
5. Determine the mass of the object by subtracting the weight of the empty beaker from the weight of the mass of beaker and object together, record this value in your Results.

250ml Beaker + First Object

6. REPEAT Steps 2 – 5 with the 250ml beaker using the first object

150ml Beaker + Second Object

7. REPEAT steps 2 – 5 with the 150ml beaker and Second Object (make sure to record results in *Second Object* results section.)

250ml Beaker + Second Object

8. REPEAT steps 2 – 5 with 250ml beaker and Second Object (make sure to record results in *Second Object* results section.

Part II (2nd Balance)

Second Balance, 150ml Beaker, and First Object

9. For this portion, use a balance different than the one used in Part I.
10. REPEAT steps 2 – 5 with the 150ml beaker with the first object (make sure you record your results in the *Second Balance* section of the results sheet).

Follow significant figures rules!

<u>Results/Observations:</u>

Part I: First Balance

First Object	ID # of 1st Object	________________	
		150ml Beaker	250ml Beaker
	Mass of Beaker + 1st Object	________________	________________
	Mass of Beaker	________________	________________
	Mass of 1st Object	________________	________________
Second Object	ID # of 2nd Object	________________	
		150ml Beaker	250ml Beaker
	Mass of Beaker + 2nd Object	________________	________________
	Mass of Beaker	________________	________________
	Mass of 2nd Object	________________	________________

Part II: Second Balance

	150ml Beaker
Mass of Beaker + 1st Object	________________
Mass of Beaker	________________
Mass of 1st Object	________________

Final Calculations

	150 ml Beaker
ID # of first Object	________________
Mass of 1st Object from 1st balance	________________
Mass of 1st Object from 2nd balance	________________
Difference of Mass	________________

Post-Lab Questions

1. Why are masses in the chemistry laboratory usually determined by the *difference* method (using a beaker to contain the object to be weighted, rather than just placing the object directly on the pan of the balance)?

2. Why should the mass of an object never be determined while the object's temperature is above room temperature?

3. Why should liquids never be poured on or near the balance?

4. Why is it important always to use the *same balance* during the course of an experiment? Explain using examples from your own data.