Experiment 5
Measurements - Mass

Jay C. McLaughlin
Colorado Northwestern Community College

Name:

Date:

Key Objectives

1. Understand the difference between Accuracy and Precision.
2. Understand how electronic instruments are calibrated.
3. Measure a requested quantity of a solid chemical.

Discussion

The *mass* of an object indicates the amount of matter present in the object. The *weight* of an object is a measure of the attraction that Earth has for the object. Because this attraction is proportional to the mass of the object, we will use the terms *mass* and *weight* interchangeably. The two most common devices used to measure mass are discussed below.

Triple beam balance

Before the advent of electronic balances, the triple beam balance was routinely used to measure masses. This is a **direct** measurement of mass by comparing the mass in the pan to the masses on the other side of the scale. While very accurate, triple beam balances are slow to use. We will not be using the triple beam balance in class.

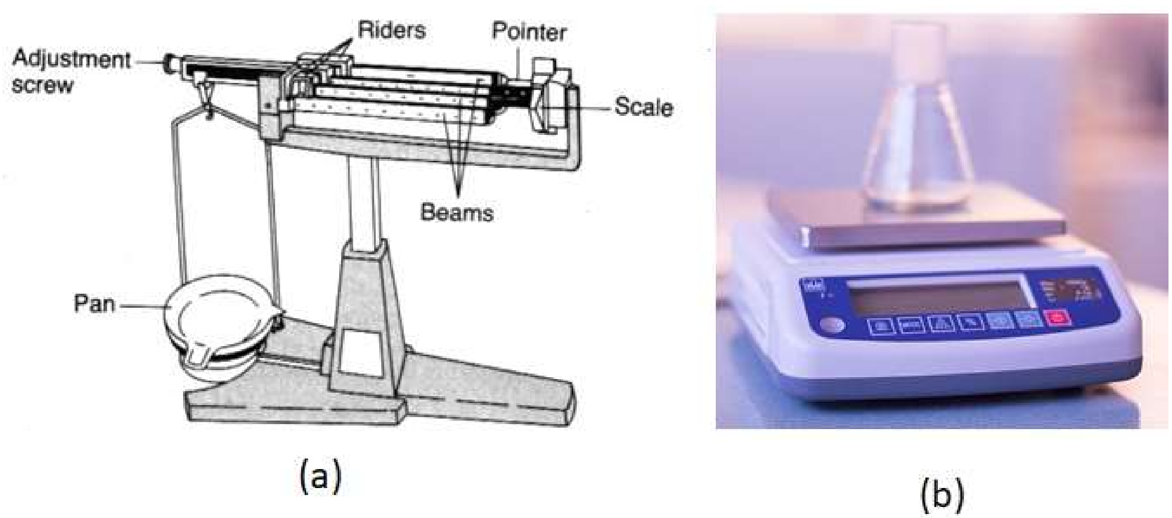

Figure 5.1: (a) Triple beam balance (b) Electronic balance. credit: (a) unknown (b) `https://commons.wikimedia.org/wiki/File:Electronic_scale.jpg`

Electronic balance The electronic balance provides an easy, precise and accurate way to measure mass. The precision and accuracy of electronic balances is generally a function of cost and can range from 0.1 gram (for 20 dollars) to 0.0001 gram (1000's of dollars). Electronic balances are an **indirect**

way to measure mass, the mass push's down on the pan resulting in a change in magnetic field required to balance the weight. The balance must have calibration adjustments made to compensate for gravitational differences from changing locations and altitudes. This is achieved by **calibrating** the scale to a two known masses. The first mass used is generally zero (empty) and the second depends on the mass range of the scale (100.0 grams for out scales).

The electronic balances are an expensive piece of laboratory equipment and the utmost care should be taken when using them. Do not pour liquids over the scale, instead pour them into a pre-weighed or tared beaker. Abuse or misuse of the scales will result in removal and usage of the triple beam balances only.

Calibration

1. Calibration should be done the first time a measurement is made or anytime the scale is moved, bumped, left sitting for an extended period of time or if you looked at it cross-eyed. Subsequent measurements made should double check the calibration of your scale.
2. Turn the scale on by holding the "ON" button for 5 seconds. The screen should read a model number and then read "MENU". Release the button.
3. The screen should then read "CAL" which means the scale is in calibration mode.
4. With no mass on the scale push the "ON/ZERO" button to calibrate the zero point on the scale.
5. After the scale is done blinking (1-2 seconds) the scale will prompt you to place the "100 g" calibration mass on the balance. After placing the mass on the scale push the "ON/ZERO" button.
6. The calibration is now complete.
7. The calibration mass should be within 0.005 grams of the correct value, if not inform your laboratory instructor.
8. Remove the mass and zero the scale.
9. The scale is now ready for making mass measurements.

Measurements

Mass measurements can be made one of two ways. The **method of differences** requires one to weigh the container used to mass a chemical, and then subtract that from the mass of the chemical plus container. This method is useful when sharing a scale, making measurements over a long period of time, or making measurements with liquids and will be used in some experiments.

For quick measurements or measurements that need to only be made once, the second method of **taring** is preferred. Using this method of weighing a chemical one places the empty weighing container on the scale and then **tares** or rezero the scale. This eliminates the mass of the weighing container and one is then able to measure only the mass of the chemical. The general procedure for making measurements in this manner is described below.

1. Tare the balance by placing the container you will measure your chemical in on the balance and pushing the "'Tare"' or "'Zero"' button.
2. Remove the container from the scale and add the chemical to be massed.
3. Place the container + chemical to be measured in the balance pan. **NEVER** place chemicals directly on the balance pan, always use an appropriate container to hold the chemicals.

4. **NEVER** pour liquids directly over the scale, instead weight or tare the appropriate container, remove it from the scale, pour the liquid in, and place the container+liquid on the scale to be weighed.
5. **NEVER** overload the scale. The maximum mass placed on the scale should be 120 grams.
6. When measuring small masses (less then 1 gram) lower the plastic air shield to improve the accuracy of your measurements.

Measuring Requested Quantities

In most laboratory exercises you will be required to make many different measurements of volume, mass, and other quantities. Often, the precision required to produce a reliable results is quite different than the precision to which you can make the measurement. While you should always write down the measured value with as many significant figures as possible as possible, you do not always need exactly the specified value. For instance, if the instructions say to measure out 1.0 gram of a substance it is implied that the needed amount is 1.0 ± 0.1 grams, thus you should make sure your measurement is between 0.9 and 1.1 grams. It is not necessary (nor desirable) to try to measure exactly 1.000 grams of solid out, and often it is a waste of time to do so. When in doubt about how precise a measurement should be, ask your laboratory instructor.

Key Idea: Making Measurements

Always calibrate your scale before use. When measuring required quantities weigh out an approximate amount, but **always** record your result to as many significant figures as possible.

Procedure

1. Check the calibration of the balance using the instructions given in the discussion portion of the laboratory.
2. Record the mass written on the reference/known weight.
3. Record the measured mass of the reference/known weight. The reference/known mass should be within 0.005 g of the correct mass. If it is not, recalibrate the scale and inform the instructor.
4. Obtain an unknown mass from your instructor and record the identity of the unknown mass.
5. Record the mass of your unknown.
6. Verify you measured the correct mass by comparing your answer to the instructors answer. If your answers are more than 0.005 grams apart, you will need to redo the measurement.

Results

1. Mass can be read with what uncertainty (±): ______________
2. Weight of reference/known mass (value given on bottle): ______________
3. Measured weight of reference/known mass: ______________
4. Identity of unknown mass (A-Z or 1-10): ______________
5. Weight of unknown mass: ______________
6. Verify result with your Instructor: ______________
7. Mass of salt weighted out (student): ______________
8. Mass of salt weighted out (instructor): ______________
9. Percent error in measured mass of salt: ______________

Questions

1. In this experiment are we more concerned with Accuracy or Precision? Explain.

2. Why does an electronic balance need to be calibrated before each use? Explain.

3. Does the calibration mass have to weigh 100 grams? Explain.

4. The directions for an experiment state "weigh 15.50 grams of sodium chloride".

   (a) Minimum amount of sodium chloride that would satisfy the directions. 4(a) ____________

   (b) Maximum amount of sodium chloride that would satisfy the directions. 4(b) ____________

5. If asked to weigh out 6.70 oz of sodium chloride, how many grams should you weigh out? Explain. 5. ____________

.