Lab 1 Weighing with an Analytical Balance

Purpose: You will learn how to weigh samples using an analytical balance.
Note: This lab should be completed during the weeks of 1/26 and 2/2.

Introduction: Analytical balances used in this experiment are much more sensitive than the top loading balances you use in general chemistry, as they weigh to the nearest $1/10000^{th}$ of a gram. This sensitivity is necessary for the quantitative experiments you will perform this semester.

Apparatus: We will use two different kinds of balances. The top loading balance weighs to nearest 0.01 g and the analytical balance with sliding doors, weighs to the nearest 0.0001 g.

Part 1: PERCENT WATER IN A HYDRATE

Water is present in many compounds, especially inorganic salts. This water may be present in stoichiometric or nonstoichiometric amounts. Chemically bound water is usually present in a stoichiometric ratio as water of crystallization (or water of hydration). An example is $Na_2CO_3 \cdot 10H_2O$, which is called a hydrated salt. Nonstoichiometric amounts of water may be physically adsorbed on the surface of the crystal, occluded inside the crystal (entrapped mother liquor) or absorbed water trapped on internal surfaces and crevices.

In some cases, the water in a hydrated salt is loosely bound, so the water is easily removed by heating the hydrated salt. This forms the anhydrous salt, which means without water :

Hydrate Salt + Heat → Anhydrous Salt + Water

$$Na_2CO_3 \cdot 10H_2O_{(s)} + \text{Heat} \rightarrow Na_2CO_{3(s)} + 10\ H_2O_{(g)}$$

A convenient method for the determination of the amount of water in a salt involves an indirect gravimetric procedure. The water-containing sample is weighed, the water is volatilized in a suitable manner, and the dried sample is reweighed. The loss in weight corresponds to the water content. Such a procedure can give the correct result only if all the water is removed and if water is the only substance volatilized. The conditions required to remove water completely from a sample may range from mere standing in a dry atmosphere at room temperature to prolonged heating at several hundred degrees. Generally the lower the temperature required, the more satisfactory is the determination, because other substances are less likely to volatilize.

It should be remembered that a dried substance may be hygroscopic; that is, it may tend to regain the water lost. Consequently, the drying should be performed in a vessel that can be closed during its weighing.

Certain anhydrous salts will gain waters of hydration easily by simple exposure to the atmosphere. These salts, described as deliquescent, will absorb a relatively large amount of water from the atmosphere until eventually forming a liquid solution. Calcium chloride, $CaCl_2$, is an example of a deliquescent salt and it is used as the drying agent in our dessicators :

$$CaCl_{2(s)} + 6\ H_2O_{(l \text{ or } g)} \rightarrow CaCl_2 \cdot 6H_2O_{(s)}$$

Adapted from experiment 8-1 in Quantitative Analytical Chemistry, by Flaschka, Barnard and Sturrock; Barnes and Noble, Inc., New York, 1969

Part 2: Statistical Analysis of Penny Mass

In this part of the experiment, you will weigh a series of pennies on the analytical balances and compare your data with pooled class data.

LAB PROCEDURE

Record all data in your laboratory notebook! You will be required to turn in some of your data in order to compile a class data set.

Part 1

WEEK ONE

1. Clean two glass weighing bottles and stoppers.

2. Mark each weighing bottle and its complementary stopper with the same number using a magic marker (so the bottles and stoppers don't get mixed up). Don't use ink pens!

3. Place the weighing bottles **(OPEN !!)** with their stoppers beside them in a 250 mL beaker. Cover with an 8.0 cm ribbed watch glass and place in an oven at 120 ºC for 1 week.

Note : Instead of repeated heatings for 1 to 2 hours, coolings and weighings until constant weight is attained, these samples are heated for 1 week to ensure all the water is removed.

WEEK TWO

4. Remove the weighing bottles from the oven and place the weighing bottles **(OPEN !!)** and stoppers into your dessicator and allow them to cool for 45 minutes.

5. Close each bottle with its stopper and weigh to the nearest 0.1 mg.

6. Place 1 to 2 grams of your assigned sample in each bottle (use top-loading balance). Stopper immediately.

7. Now, using analytical balance, weigh the filled weighing bottles (and stoppers) to the nearest 0.1 mg.

8. Place the weighing bottles **(OPEN !!)** and stoppers back into the 250 mL beaker, cap with the 8.0 cm ribbed watch glass and place back in the oven for 1 week.

WEEK THREE

9. Remove the weighing bottles from the oven and place the weighing bottles **(OPEN !!)** and stoppers into your dessicator and allow them to cool for 45 minutes.

10. Close each bottle and weigh to the nearest 0.1 mg.

Clean-up :

Place your dried metal salt in the waste containers in the hood.

Clean (water then deionized water) and dry your weighing bottle for the next lab.

Part 2 Weighing your signature and comparing balances

To be completed during week of 1/26

Try this experiment with two balances, the top loader that weighs to the nearest 0.01 g and the more sensitive balance, the one with doors. You can start with either one.

1. Zero the balance by pressing the "TARE" key on the front face. This should give a digital display of either 0.00 g for the top loader and 0.0000 g for the ones with doors.

2. Place a piece of paper near the center of the balance pan and record the mass directly from the digital display.

3. Remove the paper and write your signature on it.

4. Reweigh the paper with signature. Record results in your notebook. Find out how much your signature weighs by subtracting the mass of the plain paper from that of the signed paper.

5. Repeat with the other kind of balance.

Part 3 Composition of pennies

To be completed during week of 1/26

1. Find 10 pennies minted in the different years (post 1982).

2. Weigh the 10 pennies individually on the analytical balance and record mass and date of the penny. (After you are done with the measurements, put the pennies you used in the used pennies beaker.)

3. Find 10 pennies from before 1982. Weigh them on the analytical balance. Record the mass and the year.

4. Turn in your lab notebook pages with your data to the TAs.

5. Using Excel—do the following.

A) Input your data (mass and year) for the pennies and e-mail Excel file to lmoore@monm.edu.

B) Calculate the average mass and standard deviation for your post-1982 pennies

C) Calculate the average mass and standard deviation for your pre-1982 pennies