USE OF LABORATORY EQUIPEMENT

B. Laboratory Balances

A laboratory balance is used to obtain the mass of various objects. There are several varieties of balances, with various limits on their accuracy. Two common kinds of balances are the centigram (0.00) and the analytical (0.0000). These single-pan balances are found in most modern laboratories. Generally they are simple to use, but they are very *delicate* and *expensive.* The amount of material to be weighed and the accuracy required determine which balance you should use. These balances are not necessarily cross-calibrated so if you start with one particular balance, stay with that same balance! Remember to "TARE" the balance prior to any weighing. To "TARE" means to zero out the balance. Below are some general rules about using a digital balance.

MEASURING MASS - WEIGHING

You will no doubt receive specific instructions on the use of chemical balances in your laboratory. No attempt will be made to duplicate those instructions here. Instead, comments will be limited to some general suggestions, plus identification of a term that has special meaning throughout this course.

Chemicals are *never* weighed directly on the pan of a laboratory balance. Instead, the mass is determined by a process known as ***weighing by difference*****.** A suitable container - a small beaker, or weighing boat, or perhaps a test tube that is to be used in the experiment - is weighed empty on the balance. The desired chemical is added to the container, and the total mass of the combination is determined. Then by subtracting the mass of the empty container from the mass of the container plus chemical, you find the mass of the chemical.

Throughout this course the word **container** is used to include any and all objects that pass through the entire experiment unchanged in mass. In addition to a test tube, for example, you might include in the mass of the **"container"** which could be either a test-tube holder by which the test tube is suspended on a balance during weighing, or the mass of a beaker in which the test tube is held for weighing. For example in chemistry 101, in one experiment the mass of a liquid is measured in a Erlenmeyer flask that is covered with a Styrofoam cup. The cup is weighed with the empty flask, and their combined masses make up the mass of the **"container."** In the various experiments where you see the "container" identified, the word has the meaning given in this paragraph.

Sometimes students use containers that are not actually part of the experiment in taking samples of solid chemicals. Most common is the practice of placing a piece of weighing paper on the pan of a balance, transferring the required quantity of chemical to the paper, and then transferring it to the vessel to be used in the experiment. If you use this technique to obtain a measure mass of the chemical, your first weighing should be of the paper with the chemical on it. Then transfer the chemical, and bring the paper back for a second weighing. This way your difference will be the mass of the chemical actually transferred, unaffected by any chemical that may have remained on the paper unnoticed. In this method you should use a hard, smooth paper - waxed weighing paper is best - rather than coarse paper, such as paper towel, which is certain to trap powders and tiny crystals.

Laboratory balances are subject to corrosion. Both the balances and the balance area should be kept clean, and spilled chemicals should be cleaned up immediately.

General "how to" directions for using the balances.

Your instructor will give specific directions on how to use the balance, but the following precautions should be observed:

1. The balance should always be “zeroed” before anything is placed on the balance pan. On an electronic digital balance, this is done with the “tare” or “T” button. Balances without this feature should be adjusted by the instructor.
2. Never place chemicals directly on the balance pan; first place them on a weighing paper, weighing “boat”, or in a container. Clean up any materials you spill on or around the balance.
3. Before moving objects on and off the pan, be sure the balance is in the “arrest” position. When you leave the balance, return the balance to the “arrest” or standby position.
4. Never try to make adjustments on a balance. If it seems out of order, tell your instructor.

Here are a few miscellaneous pointers on proper balance operation, given as a series of “do’s and don’ts,” with some items in both lists for emphasis:

DO: **Allow hot objects to cool to room temperature before weighing.**
Close the side doors or hood of a milligram balance while weighing.
Record all digits allowed by the accuracy of the balance used, even if the last digit happens to be a zero on the right side of the decimal point.
Tare the balance prior to any weighing made.

DON’T : **Weigh objects that are warm or hot.**
Weigh objects that are wet (evaporation of water will change the mass).
Weigh volatile liquids in uncovered vessels.
Touch the object with your hand if you are using a milligram or analytical balance; your fingerprints have weight, too!
Forget to check the zero on a milligram balance after weighing.
Forget to record the mass to as many digits as the accuracy of the balance allows - and no more.

SIGNIFICANT FIQURES in relationship to Balances

Precise Quantities versus Approximate Quantities

In conducting an experiment it is often unnecessary to measure an exact quantity of material. For instance, the directions might state, “Weigh about 2 g of sodium sulfite.” This instruction indicates that the measured quantity of salt should be 2 g plus or minus a small quantity. In this example 1.8 to 2.2 g will satisfy these requirements. To weigh exactly 2.00g or 2.000 g wastes time since the directions call for approximately 2 g.

Sometimes it is necessary to measure an amount of material precisely within a stated quantity range. Suppose the directions read, “Weigh about 2 g of sodium sulfite to the nearest 0.001g.” This instruction does not imply that the amount is 2.000 g but that it should be between 1.8 and 2.2 g and measured and recorded to three decimal places. Therefore, four different students might weigh their samples and obtain 2.141 g, 2.034 g, 1.812 g, 1.937 g, respectively, and each would have satisfactorily followed the directions.

Significant Figures in Calculations

The result of multiplication, division, or other mathematical manipulation cannot be more precise than the least precise measurement used in the calculation. For instance, suppose we have an object that weighs 3.62 lb. and we want to calculate the mass in grams (3.62 lb.) $(\frac{453.6g}{1lb})$ = 1,642.032 when done by a calculator. To report 1,642.032 g as the mass is absurd, for it implies a precision far beyond that of the original measurement. Although the conversion factor has four significant figures, the mass in pounds has only three significant figures. Therefore the answer should have only three significant figures; that is, 1,640 g. In this case the zero cannot be considered significant. This value can be more properly expressed as 1.64×10^4 g.