1. The Laboratory Balance: Mass Determinations

Objective

Familiarity with the various instruments used for making physical measurements in the laboratory is essential to the study of experimental chemistry. In this experiment, you will investigate the uses and limits of the various types of laboratory balances.

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 some substance. That is, the mass of a sample is a direct indication of the number of atoms or molecules the sample contains. Since chemical reactions occur in proportion to the number of atoms or molecules of reactant present, it is essential that the mass of reactant used in a process be accurately and precisely known.

Various types of balances are available in the typical general chemistry laboratory. Such balances differ in their construction, appearance, operation, and in the level of precision (number of significant figures) they permit in mass determinations. Three of the most common types of laboratory balance are indicated in Figures 1-1, 1-2, and 1-3. Determine which sort of balance your laboratory is equipped with, and ask your instructor for a demonstration of the use of the balance if you are not familiar with its operation.

The method of operation differs for the three types of balances, and you should ask your instructor for a demonstration of the proper procedure to use. There are, however, some general points to keep in mind when using any balance:

1. Always make sure that the balance gives a reading of 0.000 grams when nothing is present on the balance pan. Adjust the tare or zero knob if necessary. If the balance cannot be set to zero, ask the instructor for help.
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.
3. No reagent chemical substance should ever be weighed directly on the pan of the balance. Ideally, reagents should be weighed directly into the beaker or flask in which they are to be used. 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 of reagents.
4. Procedures in this manual are generally written in such terms as "weigh 0.5 grams of substance (to the nearest milligram)." This does not mean that exactly 0.500 grams of substance is needed. Rather, the statement means to obtain an amount of substance between 0.450 and 0.550 gram, but to record the actual amount of substance taken (e.g., 0.496 grams). Unless a procedure states explicitly to weigh out an exact amount (e.g., "weigh out exactly 5.00 grams of NaCl"), you should not waste time trying to obtain an exact amount. However, always record the amount actually taken to the precision of the balance used.

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 mass determinations that are significantly less than the true value.
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 weighings in the laboratory should be performed by a difference method: an empty container is weighed on the balance, and then the reagent or object whose mass is to be determined is added to the container. The resulting difference in mass is the mass of the reagent or object. Because of possible calibration errors, the same balance should be used throughout a procedure.

SAFETY PRECAUTIONS

- **Wear safety glasses at all times while in the laboratory.**

Apparatus/Reagents Required

Unknown mass samples provided by the instructor, rubber stoppers, small beakers

FIGURE 1-1

Triple beam balance. Never weigh a chemical directly on the balance, since it is more difficult to zero this type of balance if the balance becomes dirty.

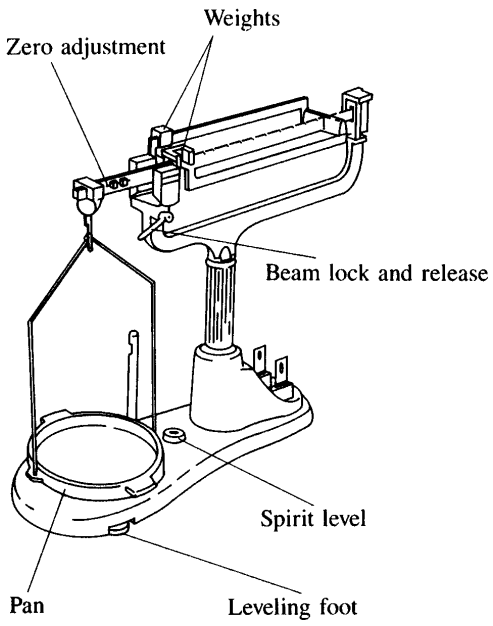


FIGURE 1-2

Top-loading electric balance. This sort of balance is operated manually: the digits are dialed in by the operator until the pointer comes to rest on a whole number.

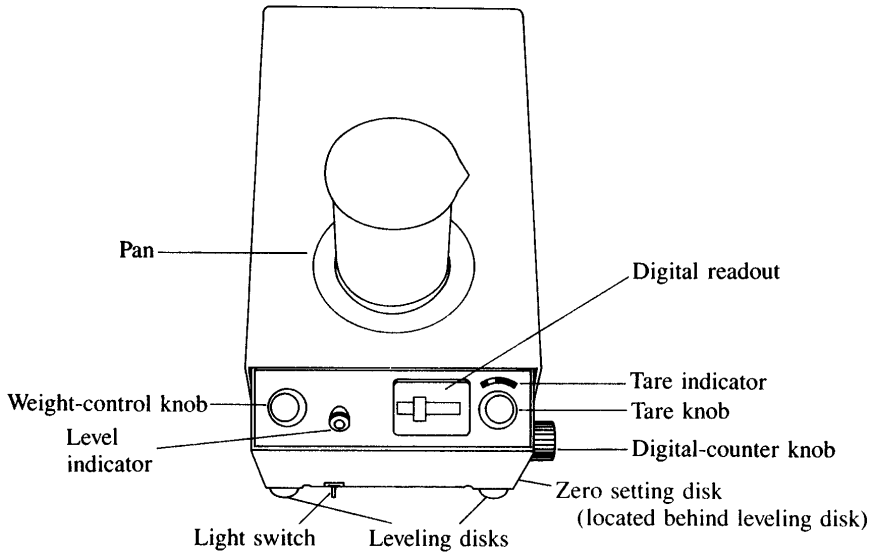
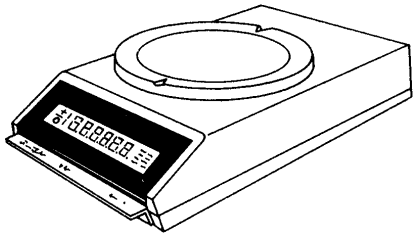


FIGURE 1-3

Digital electronic balance. The balance directly gives the mass when an object to be weighed is placed on the pan.



Procedure

Record all data and observations directly in your notebook in ink.

Examine the balances that are provided in your laboratory. If you are not familiar with the operation of the type of balance available, ask your instructor for a demonstration of the appropriate technique. In particular, make certain that you are able to determine the level of precision permitted by each type of balance available.

Your instructor will provide you with several small objects whose mass you will determine. The objects are coded with an identifying number or letter. Record these identification codes in your notebook and on the report page.

Determine and record the mass of a small beaker that can accommodate the objects whose masses are to be determined. The determination of the beaker's mass should be to the level of precision permitted by the particular balance you are using.

Transfer the first unknown object to the beaker, and determine the combined mass of the beaker and object. Record. Determine the mass of the unknown object by subtraction. Record.

Determine and record the masses of each of the remaining objects in the same manner.

Use a different balance from that used earlier, and determine the masses of each of the unknown objects on the second balance in the same manner already described. The determination of the beaker's mass should be to the level of precision permitted by the particular balance you are using.

Compare the masses of the objects as determined on the two balances. Is there a difference in the masses determined for each object? In future experiments, always use the *same balance* for all mass determinations in a given experiment.

Show the results of your mass determinations of the unknown objects to your instructor, who will compare your mass determinations with the true masses of the unknown objects. If there is any major discrepancy, ask the instructor for help in using the balances.

The Laboratory Balance: Mass Determinations

Date: ..... Student name: .....

Course: ..... Team members: .....

Section: .....

Instructor: .....

Prelaboratory Questions

1. What are the differences in meaning between *mass* and *weight*? In the laboratory, do we determine the mass or the weight of objects?

2. Explain the following: Weigh approximately 5 grams of NaCl to the nearest milligram.

The Laboratory Balance: Mass Determinations

Date: ..... Student name: .....

Course: ..... Team members: .....

Section: .....

Instructor: .....

Results/Observations

1. First balance

Mass of empty beaker .....

ID number of object	Mass of beaker plus object	Mass of object itself
.....	.....	.....
.....	.....	.....
.....	.....	.....

2. Second balance

Mass of empty beaker .....

ID number of object	Mass of beaker plus object	Mass of object itself
.....	.....	.....
.....	.....	.....
.....	.....	.....

3. Difference in masses determined on the two balances

ID number of object	Difference in mass
.....	.....
.....	.....
.....	.....

Questions

1. Why is it important always to use the *same balance* during the course of an experiment?

2. What *error* is introduced in a mass determination if the object being weighed is *warm*? Why?

3. Why should reagent chemicals *never* be weighed directly on the pan of the balance?