Purpose of the Experiment

Practicing techniques for weighing objects and measuring the volumes will allow you to be more adept in the lab environment. Determining the number of significant figures that can be recorded with a measurement is essential for further work in any science class.

Background Information

I. Transferring Chemicals in the Laboratory

In the laboratory, you will work with a variety of solids and liquids. Learning effective techniques for measuring and weighing these chemicals will improve your experimental results. Also, the techniques you use must protect you, your equipment, and the purity of the chemicals.

A. General Procedures

Always handle chemicals with caution. Carefully read the label on each reagent bottle you use to ensure that you are selecting the correct substance for that particular experiment.

Do not take any more of the chemical than you estimate you will need for the experiment. If it turns out that you didn’t take enough of a particular reagent you can get more. If you have obtained too much, do not return any excess to the reagent bottle. This can cause contamination of the reagent supply. Instead, discard any excess in the appropriately labeled collection container.

Label your containers. Many chemicals are identical in appearance so it is easy to confuse them.

B. Transferring Solids

You can transfer a small amount of solid from one container to another with a clean, dry spatula. You can also transfer solid to a piece of creased weighing paper first and then to another container. If you need to weigh the sample you are transferring the weighing paper technique will work great.

To avoid possible contamination of a reagent in a container, it is best to not place the lid or stopper from any container directly on the laboratory bench. If necessary, you can place the lid or stopper on a piece of clean paper. You can also hold the stopper between your fingers. – see demonstration by instructor.

C. Transferring Liquids

To avoid splashing when pouring liquid from one beaker to another, use a stirring rod to guide the liquid flow.
II. Determining the Masses of Objects

You will use balances to measure the masses of solids, liquids, and solutions. There are many different types of balances. They differ in their precision, with the triple-beam being the least precise and the electronic analytical being the most precise. The type of balance you use will determine how precisely you can measure the mass of the material you are weighing.

A. General Rules for Using Any Balance

Never place chemicals directly on a balance pan. Instead, place chemicals on a piece of weighing paper or in a container first. Otherwise, you may damage the balance.

Never place hot objects on a balance pan. Allow such objects to cool to room temperature before you attempt to weigh them. Otherwise, your mass measurements will be inaccurate. Heated objects may also damage the balance.

Never attempt to level the balance. Inform your laboratory instructor if your balance does not appear to be level.

Immediately clean up any substance you spill on or near the balance, following the directions of your laboratory instructor.

Always make certain that the balance is at zero before you begin weighing and after you finish weighing. If the balance does not register zero at these times, consult your laboratory instructor. Do not attempt to adjust the zero setting by yourself.

B. Using the Tare Function of Top-Loading or Analytical Balances

You will commonly determine the mass of a solid or liquid by difference. You will do this by first establishing the mass of an empty container. Then, weigh the mass of the container plus the sample. The mass of the sample is calculated by difference.

In order to simplify this procedure, many electronic balances feature a tare function, a mechanism that counterbalances the mass of the empty container and resets the balance reading to zero with the container on the balance. Using this function, you can set the balance reading to zero with the empty container on the pan. Then the balance reading will directly indicate the mass of any sample added to that container.
III. Measuring the Volumes of Liquids

In the laboratory, you will measure volumes of liquids and solutions using calibrated glassware, including graduated cylinders. To precisely determine the volume of liquid in a glass cylinder, one reads the liquid level using the bottom of the bowed liquid surface, or meniscus. Note: The liquid surface in a plastic cylinder is usually flat rather than curved.

Procedures

I. Weighing Objects
   a. Obtain the two objects you will weigh from your laboratory Instructor. Identify these as “object 1” and “object 2”, and record their Identification codes. Throughout this experiment always use crucible tongs or forceps to handle the items you are weighing. This keeps oils from your hands from changing their mass and helps to create good lab habits.
   b. If the balance is not already turned on, press the on/off button or control bar to turn it on. The display should show 0.00 g. If it does not, consult your laboratory instructor.
   c. Place a piece of weighing paper on the balance pan. The mass of the paper will appear on the display. Press the control or tare bar to tare the paper on the pan. The balance display should show 0.00 g again.
   d. Using crucible tongs, gently place object 1 on the weighing pan. Read the mass of object 1 from the balance display. Record this mass. Use the crucible tongs to remove object 1 and the weighing paper from the pan.
   e. Repeat Steps c and d, using object 2. Using crucible tongs, remove the objects from the balance pan.

II. Determining the volume of a solid
   a. Measure the dimensions of the object (length, width, height, or diameter, etc) in centimeters and calculate the volume in cm$^3$, which is one mL.
   b. Determine the volume by difference:
      i. Fill a graduated cylinder half way and read the volume.
      ii. Place the solid into the cylinder (careful here – no dropping) and read the volume.
      iii. The volume of the object is the difference between ii and i.
   c. Calculate the density of the object from the mass and volume data.
III. Measuring the volume of three pieces of glassware
   a. Choose three pieces of glassware that you are curious as to their volume.
   b. Fill each of them with water and make sure the mass is not too heavy (the weighing apparatus will show error if you chose something too big).
   c. Record the full mass.
   d. Before discarding the water, measure the temperature to the correct number of significant figures.
   e. Dry each piece and weigh them empty.
   f. Determine the mass of water in each by difference (c – e).
   g. From the temperature reading, determine the density of the water from the chart provided.
   h. Calculate the volume from the mass and density.

IV. Determining the Density \([m/V]\) for three objects
   a. Obtain the three objects for which you will determine density from your laboratory Instructor.
   b. Determine the mass for all three objects AND determine the volumes – calculated or by difference;
   c. Remember that density equals mass divided by volume and determine the density for all three objects;
   d. Order their density highest to lowest: \(1 > 2 > 3\)

V. Determining the Number of Drops in 1.0 ml. of Water
   a. Label a clean, dry 20 x 150-mm test tube. Pour 5.0 mL of water from a graduated cylinder into the test tube.
   b. Use a glass-marking pencil or a gummed label to mark the height of water. Measure the water height in millimeters. Record this height. Pour the water from test tube into the drain.
   c. Using a medicine dropper or Pasteur pipette, count the number of drops of water required to fill the test tube to the marked height. Record this number of drops. Pour the water from test tube into the drain.
   d. Repeat the above steps, using a clean, dry, 20 x 150-mm test tube and a different volume. – Do this for a total of three runs.
Post-Laboratory Questions

1. For object 1, compare the volume you determined using lengths with the volume you determined by displacement. If the volumes are identical, please comment on the relative ease of each technique. If these volumes differ, suggest a reason for the difference.

2. Based on your calculated number of drops in 1 mL of water, how reproducible were your drop volumes? Briefly explain.

3. The calibration marks on a 100-mL and a 10-mL graduated cylinder are different. Briefly explain why it would be more accurate to measure 9.7 mL of water using a 10-mL graduated cylinder, rather than using a 100-mL cylinder.

4. Now that you have experience using the tare function of a balance, list the steps you would follow to weigh exactly 135 g of table salt (NaCl) on an electronic balance and then transfer the NaCl to a test tube. Include directions for using the tare function.

5. Briefly explain why you should never take more of a chemical than you estimate you will need for an experiment.

6. Comment on the density differences for the three objects you measured in Section IV. Can you conclude anything relative to material type and the densities?