

Measuring Mass and Volume

Reminder – Goggles must be worn at all times in the lab.

PRE-LAB DISCUSSION:

Measurements in laboratory work are an essential part of making reliable observations. Measurements that can be made include those of mass, volume, temperature.

For laboratory work in chemistry, three basic types of measurement using the balance should be mastered. These are: measuring mass directly, “measuring out” a specific mass of a substance, and determining mass by difference. These three types of measurement and the techniques for making them are briefly described in the following paragraphs. Oddly, the metric standard for mass is the kilogram. However, this unit is too large for our purposes, and we will measure mass in grams.

The liter is the standard unit of volume in the metric system, but that is generally too large for our purposes. We will measure volume in milliliters (mL). There is an equivalence between mL and cm^3 , so that

$$1 \text{ mL} = 1 \text{ cm}^3$$

Generally, our measurements of volume will be made with graduated cylinders. For measuring very specific volumes, the volumetric flask is the tool of choice. On rare occasions when we need only a crudely measured “approximate” quantity, we may use beakers for measurement.

PURPOSE:

The purpose of this lab is to practice the various techniques of measuring mass and volume using laboratory tools.

PROCEDURE:

I. Using the Balance.

The proper use of the balance is described in the following steps:

- A.** When transporting a balance, be careful to hold it steady in order to protect the beams and “knife edge.” NEVER BANG ON THE BEAMS. Check to see that the balance is properly “zeroed.” To do this, be sure the pan is clean and empty, and set the riders to zero. The pointer should swing an equal distance on each side of the zero point. If it does not, use the adjustment screw to obtain an equal swing of the pointer.
- B.** NEVER PLACE CHEMICALS DIRECTLY ON THE PAN. Samples to be measured should be placed on a piece of paper or in a container. Never place hot objects on the balance. Allow samples to cool before measuring.
- C.** Once the object whose mass is to be determined is on the pan, move the rider of greatest mass along its beam, one notch at a time, until it causes the pointer to drop. Then move the rider BACK one notch. Repeat this procedure with each succeeding rider of smaller mass. Make sure each rider is securely in its notch. The front beam, which is marked off in the smallest increments, is not notched. Slide the rider on this beam until the pointer swings an equal distance on each side of the zero on the scale.
- D.** When the pointer is zeroed, sum up the masses shown on the beams. Remember, significant figures are all figures known with certainty AND ONE GUESS. With our scales, we can read down to the hundredths place for CERTAIN and we can GUESS the thousandths place. Therefore, in this class, ALWAYS record all masses to THREE PLACES PAST THE DECIMAL POINT.

Example: 4.125 grams. The “5” would be a guess to indicate that the pointer was half-way between two markings.

See the following examples. Remembering to GUESS the thousandths place, the first scale reads 24.560 grams and the second figure reads 107.060 grams.

II. Measuring Mass Directly.

- A. Check your balance to make sure your pointer is properly “zeroed.”
- B. Place a penny on the pan. Move the riders until the pointer is balanced (zeroed). Record the mass of the penny.
- C. Repeat step 2 for the objects listed below. Record the mass of each object.
 - 1) a penny
 - 2) a nickel
 - 3) a watch glass
 - 4) a 10 mL graduated cylinder

III. Measuring Out A Predetermined Mass.

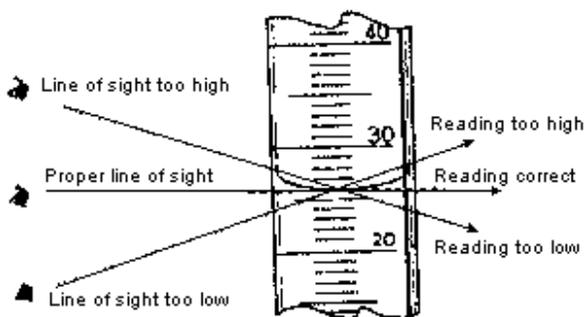
- A. Place your clean watch glass on the balance. Move the rider on the beams until the balance is zeroed. Record this reading (this should be the same reading as in the previous section).
- B. Now, move the riders until they read exactly 1.000 grams MORE than the reading you obtained for the watch glass. Record this setting.
- C. Using the sodium chloride (NaCl) provided by your instructor, and your spatula, add NaCl to the watch glass until the pointer is balanced. This is the method you would use if your instructor directed you to “weigh out 1.000 grams of NaCl.”
- D. Discard the NaCl in the waste bin when you are finished. NEVER RETURN USED CHEMICALS TO A STOCK BOTTLE DUE TO THE RISK OF CONTAMINATION.

IV. Determining Mass By Difference

- A. Measure and record the mass of your 10 mL graduated cylinder (you may use the result obtained previously).
- B. Fill your graduated cylinder with EXACTLY 10.00 ml of water.
- C. Measure and record the combined mass of the cylinder and water.

V. Measurements of Volume.

- A. Take your 10 mL graduated cylinder from your drawer. Examine it and notice its markings. Each major division represents one milliliter (mL) or one cubic centimeter (cc or cm^3).
- B. Take one of your smallest test tubes and fill it completely with water. Pour the water into the graduated cylinder. Read the measurement in milliliters and record this value. Be sure you are reading at the **BOTTOM** of the curvature (meniscus). See diagram. Remember to read all values known with certainty **AND ONE GUESS**. Generally, all values for volume should be written **TWO** places past the decimal point.



Example: 3.65 mL

- C. Take your largest test tube, fill it with water, and measure the volume of water it holds with your ten mL graduated cylinder. You may need to pour into the graduated cylinder several times. Record the result.
- D. Take the 100 mL beaker from your lab drawer and completely fill it with water. Using a 100 mL graduated cylinder from the side table, pour the beaker contents into the graduate and measure the volume in milliliters (mL). Record this value.
- E. Take out your 10 ml graduated cylinder and your dropping pipet (medicine dropper). Using your dropping pipet, **COUNT** how many drops of water it takes to equal one milliliter in the graduated cylinder. Be sure you are reading at the bottom of the meniscus. Record this number. Your number may vary from those around you as dropping pipets vary greatly.

RESULTS:Data

Do NOT write here. Record all data on your lab paper! Remember to record all masses to three places past the decimal.

Part II	Mass in grams
Penny	XXXX g
Nickel	XXXX g
Watch glass	XXXX g
10 mL Graduated cylinder	XXXX g

Part III	
Watch Glass	XXXX g
Sodium Chloride	XXXX g
Total	XXXX g

Part IV	
10 mL Graduated cylinder	XXXX g
Cylinder + 10 mL water	XXXX g

Part V	
Volume of a small test tube	XXXXX mL
Volume of a large test tube	XXXXX mL
Volume of water held by beaker	XXXXX mL
Volume printed on beaker	XXXXX mL
Drops of water equal to 1 mL	XXX drops

Calculations (SHOW YOUR WORK! No work = No credit)

1. Calculate the mass of 10.00 ml of water.
2. Calculate the mass of 1.00 ml of water from your answer to the previous calculation.
3. Calculate the volume of a single drop of water.