Metric Measurement

Background

If you haven't already done so, read the metric system or SI section in your text. All measurements in chemistry are made in SI units.

In this experiment you will measure length using a ruler which can be estimated to 0.1 cm, volume using one graduated cylinder which can be read to 0.1 mL and another which can be read to 0.01 mL, and mass on a balance which weighs to 0.01 g. Look carefully at each instrument to be sure you understand it before making any measurements. All measurements should be checked twice to be sure that the readings have been recorded correctly.

The ruler is calibrated in centimeters on one side and mm on the other. Since it can be estimated to 0.1 cm, a reading of exactly twenty–eight centimeters should be recorded as 28.0 cm.

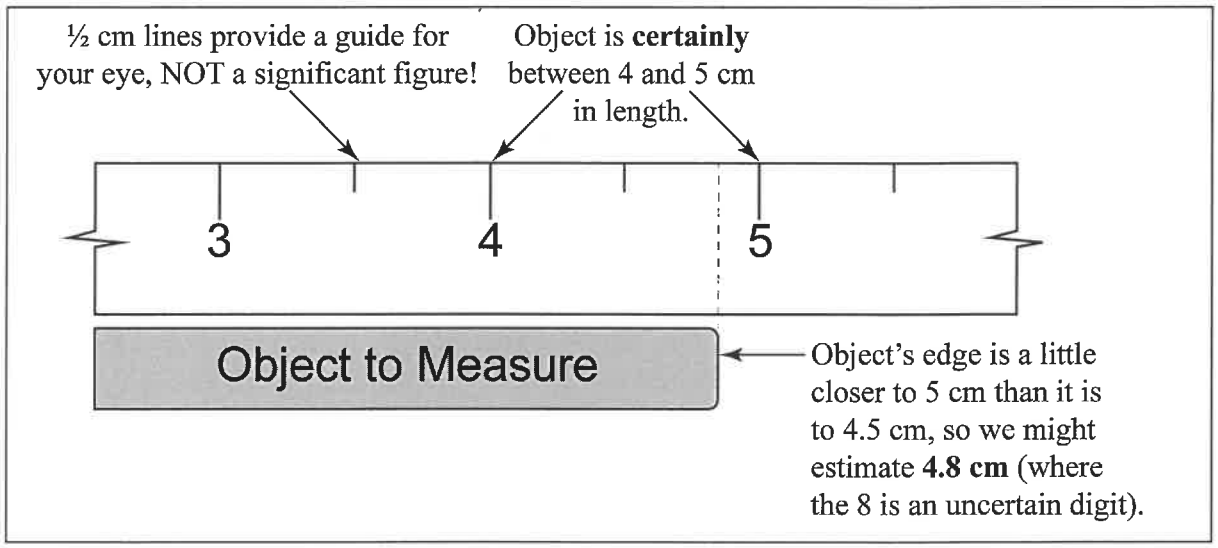


Figure 1. Using the centimeter ruler

Getting accurate volume readings from a graduated cylinder can be tricky at first. Your 50 or 100 mL graduate is calibrated in 1 mL increments, i.e., each line represents 1 mL. However, by careful reading between the lines, volumes can be estimated to the nearest 0.1 mL. Similarly, your 10 mL graduate can give volumes to the nearest 0.01 mL.

When there is water in a graduated cylinder (or any other container for that matter) the surface of the water is curved downward. This curved surface is called the **meniscus**. Volume readings are taken at the bottom of the meniscus. The meniscus must be at eye level for an accurate reading. Be sure you have read the directions carefully before you make any measurements. It is important to record data with the precision requested. For example if you are directed to measure to the nearest 0.01 mL, reporting 9.9 mL would be incorrect.

Equipment

From the stockroom:
yellow cm ruler

From your drawer:
50 or 100 mL graduated cylinder
10 mL graduated cylinder
large test tube
small test tube
crucible and lid
250 mL beaker

Procedure

All measurements should be recorded **directly** into the data pages in this lab, not on scratch paper or on the procedure.

Length–All measurements will be made with a yellow cm ruler. Measurements in centimeters are to be recorded to the nearest 0.1 cm.

1. Measure the inside width of your equipment drawer in centimeters. Convert centimeters to meters.

2. Measure the length of a large test tube in centimeters. Convert the centimeter measurement to millimeters and to meters.

3. Repeat 2 measuring the diameter of the top of your crucible.

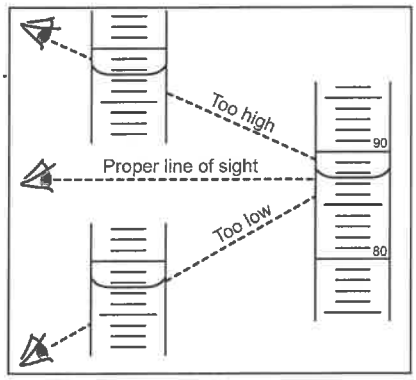
4. Repeat 2 measuring the length of this page.

Area–All measurements will be made with a yellow cm ruler. Measurements in centimeters are to be recorded to the nearest 0.1 cm.

1. Measure and record the length and width of this page in centimeters.

2. Calculate the area of the paper in cm^2 , m^2 , and mm^2 .

Volume–Measurements will be made using your graduated cylinders.



1. Measure the volume of your largest test tube by filling the test tube *to the brim* with water and pouring it into your 50 or 100 mL graduated cylinder. Report this volume to the nearest 0.1 mL by estimating the position of the meniscus between the lines. Convert this measurement to liters

2. Repeat 1 for your crucible.

3. Using your 10 mL graduated cylinder, measure the volume of your **smallest** test tube. Report this volume to the nearest 0.01 mL. Convert this measurement to liters.

4. Measure the volume of a 250 mL beaker by filling it to the brim with water and then pouring the water repeatedly into your 50 or 100 mL graduate.
   a. Add water from the beaker to the graduate to somewhere between the 90– and 100–mL marks, read and record it.
   b. Discard the liquid in the graduate and repeat step 4a until you run out of water in the beaker.
   c. The sum of these volumes is the volume of the beaker. Report that sum, and convert it to liters.

5. Using a yellow cm ruler, measure, to the nearest 0.1 cm, the diameter and height of the same 250 mL beaker used in #4. Calculate its volume in cm^3 using the formula for the volume of a cylinder, $V = \pi r^2 h$, where V is the volume, $\pi = 3.14$, r is the radius or half the diameter, and h is the height. When taking measurements with the ruler, consider where it would make the most sense to measure the diameter, given that you're trying to determine how much volume the beaker could *hold*. In the report sheet, discuss why the calculated volume should be the same as the volume measured in mL, and why they aren't the same.

Mass–The balances are located in the balance room at the side of the lab. Do not attempt to use a balance until you have been instructed in its use. These balances are delicate and quite expensive. Please treat them with care. All weighings will be recorded to the nearest 0.01 g.

1. Weigh your crucible. Record the weight in grams and convert it to milligrams.

2. Repeat 1 for your crucible lid.

3. Weigh your crucible and crucible lid together. Record the weight in grams.

4. Add the weights of crucible and lid and compare the result to the weight in #3. If these do not agree within 0.02 g repeat the weighings.

5. Obtain an equipment check–out slip from the stockroom or your instructor and weigh it. Record the weight in grams and convert it to milligrams.