Introductory Chemistry Lab: Measurement

Outcomes

As a result of today's lab session you will have:

- Watched a video about measurement.
- Measured various lengths using different devices
- Determined a conversion factor to convert between these measurement values.
- Used a thermometer to record temperatures.
- Used a balance to measure the mass of various objects.
- Measured volumes of water using different measuring devices
- Determined the best device for measuring volume.

Prelab

Prepare a Title (can use the lab handout for this), Purpose (a concise statement) and a Procedure (short "to do" list … see "Writing a Procedure" in the lab handouts folder), and Data Tables.

Purpose

To use common lab measuring devices and to design a distance conversion factor.

Background Information

In all sciences measurements are essential. The most fundamental (basic) properties that can be measured are length, mass, and time. In chemistry, temperature is also often treated as a fundamental property. Other properties (derived) such as volume or density are actual ratios or products of basic properties. For example the basic unity of volume is $length^3$, while that for density is mass/volume.

The metric system is used almost exclusively in the sciences, and the SI or System International, has been adopted as the standard measurement system. The meter, kilogram, and second are the basic units for length, mass, and time. However, in the chemistry laboratory the meter and the kilogram are too large for convenient use and most often we use the centimeter for length and gram for mass.

Units in the metric system are related to each other as multiples of ten and designated by prefixes. Some of the prefixes with those used most often are shown in the Table below.

Table 1: Common Metric Prefixes

Mega (M)	Million	10^6
Kilo (k)	Thousand	10^3
Deci (d)	Tenth	10^{-1}
Centi (c)	Hundredth	10^{-2}
Milli (m)	Thousandth	10^{-3}
Micro (μ)	Millionth	10^{-6}
Nano (n)	Billionth	10^{-9}
Pico (p)	Trillionth	10^{-12}

This lab is to acquaint you with several different types of measuring devices. When using any analog (no digital display) measuring device, always estimate and record data to one digit beyond the smallest marked graduation on the measuring device. When reading digital devices, the last digit displayed is assumed to be the estimated (doubtful) digit. Always record the units for the measurement.

Procedure

A. Video

Watch the measurement video and make notes as necessary.

B. Length

1. Select an object you have for measuring length. The object should be straight, and have no measuring marks on it (e.g., a pencil, credit card, index card, etc.)
2. Measure the length of the long edge of your lab bench with your chosen device and record your measurement in Table 1. Remember to estimate last digit for correct number of significant figures (sig figs).
3. Measure and record the length and width of your lab notebook. Do NOT include the spiral.
4. Repeat steps 2-3 using a meter stick or ruler and record your answers in Table 1.

C. Temperature

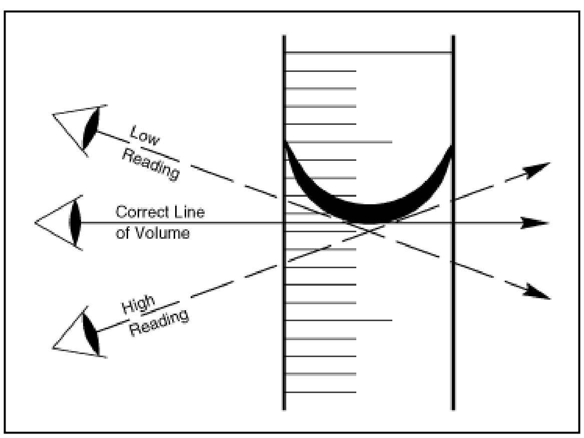
5. Use a thermometer to measure the temperature of`~ 200 mL of deionized water in a 400 mL beaker. Record each measured temperature in Table 2. Be sure of these points:
    a. The liquid in the thermometer is not moving when you make the measurement.
    b. The bulb of the thermometer is completely immersed in the water and not touching the glass.
    c. Each reading should be estimated to one digit beyond the last graduation (0.1 °C).
6. Make about 200 mL of ice slush, (25% water, 75% ice) in the same 400 mL beaker. Stir the mixture for ~2 minutes and then measure the temperature. It should be between -5 °C and +5 °C.
7. Use a hot plate to heat ~200 mL of deionied water in the same 400 mL beaker. Determine the temperature after the water begins a rolling boil. It should be between 95 °C and 105 °C.

D. Mass

8. Get a rubber stopper, a 150 mL beaker, and a watch glass.
9. Estimate the order of heaviness of each object relative to one another in Table 3
10. Tare (zero by selecting the Tare button) an electronic balance. Separately tare and weigh each object on the balance. Record all digits displayed in Table 3.
11. Tare the balance and weigh all three objects together. Record the total mass in Table 3.

E. Volume

When measuring a volume of water in a container such as a graduated cylinder, you will notice that the water is higher at the edge than in the middle and forms a meniscus. **Always read the low point of the meniscus and be sure your eye is at the same level as the meniscus.**



The volume reading is composed of two determinations: The certain digits using whatever marks are on the graduate and the "estimated (doubtful)" digit that estimates one decimal place greater than the smallest marks.

There are 10 marks between 50 and 60 mL; so, each mark is 1 mL

The meniscus is between the 52 and 53 mL marks. (52 is "certain")

The distance between the 52 and 53 marks is estimated. (So, it is "doubtful")

Since estimates will vary between observers (0.7, 0.8. or 0.9), the last digit recorded is always assumed to be doubtful.

Measurement is recorded (depends on observer) as 52.7, or 52.8, or 52.9 mL

12. Place a 150 mL beaker on the balance and then tare the balance. Add ~50 mL deionized water. Determine the volume. Immediately wipe up any spills to keep the balance dry.
13. Record the volume and mass of water in the beaker in Table 4.
14. Place a 50 mL graduated cylinder on the balance and then tare the balance. Add ~50 mL deionized water. Determine the volume.
15. Record volume and mass of water in the graduated cylinder in Table 4.

Data

Table 1: Distance Measurements

Device Used	Table length	Lab notebook length	Lab notebook width
Name of your device			
Ruler (cm)			

Table 2: Deionized Water Temperature Measurements

	Room Temperature	Ice slush	Boiling H_2O
Temperature (^{O}C)			

Table 3: Mass Measurements

	Rubber stopper	Beaker	Watch glass	All Three Objects
Estimated order of mass (1 = lightest, 3 = heaviest)				
Mass (grams)				

Table 4: Volume Measurements

	Water in Beaker	Water in Graduated cylinder
Volume (mL)		
Mass (g)		

Calculations (include the appropriate units and the appropriate number of significant figures.)

1. Devise a conversion factor that will allow you to convert from your units of length to cm.

2. You measured the mass of the beaker, stopper, and watch glass separately and together. Determine if the sum of the individual masses is the same as when measured together. Show all calculations and record the result in Table 5.

Results

Table 5: Summary

Calculated Conversion Factor	
Mass difference between the two determinations	

Conclusion

What are some important things about making measurements?
List three things you now realize are important to consider for the future whenever you will measure length, mass, or volume.

Questions (Show all work … no work displayed; no credit)

1. When making length measurements for Table 1 which do you think is more accurate, the tool you chose to use or the ruler? Why?

2. In Table 5 the mass difference should be very close to 0.000 g. If you got a mass difference, what could account for this mass difference?

3. Based on your Table 4 data and the fact that 1 mL H_2O = 1 gram, explain whether the beaker or the graduated cylinder is more accurate for volume measurements.

4. The length of a laboratory is 19.45 chemistry books. If one chemistry book = 46.72 cm, what is the length of the laboratory in meters?

5) Do the following conversions:
   a) 5.2g into kg
   b) 6.21 mL into L
   c) 4.56 cs into days
   d) 3.2 kg into mg

6) Determine the area of your lab notebook in both units (your table's units and cm).