Experiment Measurements and Conversions.

Goals

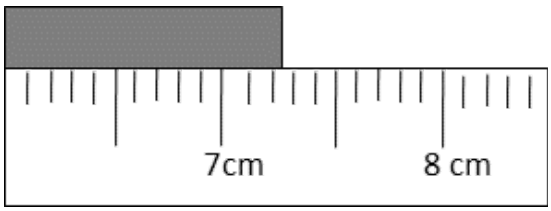
1. To become familiar with chemistry lab equipment.
2. To measure and record length, volume and mass accurately with the correct number of significant figures.
3. To use significant figures correctly in calculations.

Making Measurements

Measurements are central to science and medicine. Scientists and medical professionals need to read and report measurements accurately and precisely to convey information to others. In this lab you will learn how to read scientific instruments and report the results with the correct number of significant figures. Measurements contain certain and uncertain digits. The final digit of a measurement is assumed to have uncertainty and is usually estimated from the instrument being read. You will be expected to carefully and correctly record measurements using the procedures below for the rest of the course.

Units of Length

We will use rulers to measure length. The standard unit of length in the metric system is the meter (m). A meter is divided into 100 centimeters (cm). Each centimeter is divided into 10 millimeters (mm). Measurements taken with instruments with a scale, such as rulers, should be recorded to the one place past the smallest division.



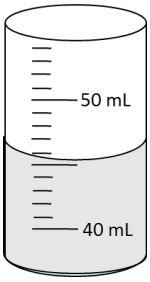
Smallest division on the ruler: 0.1 cm (ones place)
Estimate to the nearest: 0.01 cm (hundredths

The object lies between the 7.2 and 7.3 cm lines. Estimate to one place past the smallest marks. A correct reading of this instrument could be **7.24 cm**.

Units of Volume

Volume is a derived unit based on length. The unit of basic metric unit of volume is the liter (L). There are 1000 mL in 1 L. A milliliter is the same volume as 1 cm^3. We will use several types of instruments to measure volume in chemistry class.

	**BEAKER** Straight sides, wide opening	• used to hold, mix and heat liquids	• markings give an approximate volume • *beakers are not used for careful volume measurements*
	**ERLENMEYER FLASK** Tapered sides, narrow opening	• used to hold, mix and heat liquids • the shape is useful for swirling liquids without spilling and for limiting evaporation	• markings give an approximate volume • *erlenmeyers are not used for careful volume measurements*
	**GRADUATED CYLINDER** Straight sides, narrow opening	• used to accurately measure volume • **NOT** used for heating or mixing	• use the smallest size that accommodates the volume • read at eye level • read the scale increasing up if two scales are shown • read lowest part of the curved surface (the meniscus)



Liquids in glass have a curved interface known as a **meniscus**. Always read the lowest part of the meniscus.

Smallest division on the cylinder: 1 mL (ones)
Estimate to the :` 0.1 mL (tenths)

The lowest part of the meniscus is between the 45 and 46 mL marks, somewhat closer to 45mL. A correct reading of this volume could be **45.3 mL**.

Units of Mass

A laboratory balance is used to measure mass. Mass is the measure of the amount of matter. The metric unit for mass is the gram (g) while the SI unit of mass is kilogram (kg). The balance has a metal pan to weigh materials on. Around the pan, there is a plastic shield and a cover. These protect the balance from fluctuations caused by drafts.

Using a balance

- Press the button labeled "tare" or "zero" until the numbers stabilize at zero.
- If massing a chemical, place a weigh boat on the balance before zeroing. Never put chemicals directly on the balance.
- Place the material on the pan, or scoop into the weigh boat with a spatula.
- If the last digit fluctuates, you may estimate its value.
- *Write every digit on the balance on your data sheet - never round off a mass measurement*. The final digit is considered uncertain.
- Weigh boats are single use. Dispose of them once used.
- Only weigh objects that are at room temperature.

weigh boats

Procedures will often say "accurately weigh about 5g of X", this means that you do need exactly 5.000 grams, but whatever mass you portion out should be recorded accurately. For instance 5.080 g and 4.952 g might be recorded as an accurate mass of approximately 5 g. Trying to hit exactly 5.000 g is unnecessary and a waste of time.

Units of Temperature

A thermometer is used to measure temperature in the laboratory. Usually lab thermometers are in units of Celsius. We can use the following conversion equation to units of Kelvin.

$$T_K = T_C + 273$$

Reading a Thermometer

We will use digital thermometers in this class. Allow 30 seconds for the thermometer to stabilize. Like a digital balance, we ***record all digits on the screen***.

Conversion Factors

Conversion factors are often used in chemistry to convert one unit to another. A conversion factor can be made out of any two quantities that are equal to each other. We multiply by their ratio, the original units cancel, and measurement is converted to the new unit.

Equality: 1 m = 3.28 ft Conversion factors: $\frac{1\text{ m}}{3.28\text{ ft}}$ or $\frac{3.28\text{ ft}}{1\text{ m}}$

To convert 2.68 m to feet, multiply by the second conversion factor – the unit you want to cancel should be in the denominator.

$$2.68\ \cancel{m} \times \frac{3.28\ ft}{1\ \cancel{m}} = 8.79\ ft$$

More than one conversion factor can be used in sequence when there is no one conversion factor to go between units. For example we can use two conversion factors to convert 2550 ft to km:

$$2550\ \cancel{ft} \times \frac{1\ \cancel{m}}{3.28\ \cancel{ft}} \times \frac{1\ km}{1000\ \cancel{m}} = 0.777\ km$$

When doing conversion problems, always write out units, always be sure that they are canceling properly and verify that the only unit left is the unit of your desired answer (in the case above, km).

1 km = 0.621 mi **1 in = 2.54 cm *** **1 mi = 5280 ft *** **1 ft = 12 in ***

1 kg = 2.20 lb **1 lb = 454 g** **1lb = 16 oz ***

1L = 1.06 qt **1 gal = 4 qts *** **1 gal = 3.79 L** *** = exact**

1 kx = 1000 x * **1 x = 100 cx *** **1 x = 1000 mx*** **1x = 1000000μx ***

Laboratory Activity

Materials: wooden block beaker graduated cylinders thermometer
Ruler sand ice

Procedure

A. Measuring Length

1. Find a ruler with centimeters. Choose a wooden block and note its letter on your data sheet. Measure the length, width and height to the correct number of significant figures. Multiply these values to find the volume in cubic centimeters.
2. Make your own conversion factor – measure the height of a 250 mL beaker in inches and in centimeters. Divide these numbers to find the centimeters per inch. Compare this to the actual value 2.54 cm = 1 in.

B. Measuring Volume

3. Partially filled 10 mL, 100 mL and 1000 mL graduated cylinders will be placed in the front of the classroom. Read these cylinders to the correct number of significant figures.

C. Measuring Mass

4. Turn on the balance and hit tare/zero until it reads 0.000 g.
5. Place the wood block from Part A on the balance and record the mass. *Always record all digits on a balance*. If the last digit fluctuates without settling, estimate it. Convert this mass to pounds.
6. Place the beaker from Part A on the balance and record the mass. Convert this mass to kg.
7. Powdered or granular solids are weighed in disposable plastic weigh boats, not directly on a scale. Place a weigh boat on a scale and tear until it reads 0.000 g. Add sand from a provided vial into the weigh boat and record the mass of the sand. Put the sand back in the vial by folding the weigh boat and then put the weigh boat in the trash can. Convert this mass to µg.

D. Measuring Temperature

8. Fill a beaker about 1/3 with deionized water. Measure the temperature with a thermometer. Record all digits for any digital measurement.

9. Add approximately the same volume of ice to the water in the beaker. Wait for the temperature to stabilize and record it on your data sheet. Convert both measurements to Kelvin. K = ^{o}C +273

Name_____

CHM101 Lab – Measurements and Conversions – Grading Rubric

Criteria	Points possible	Deductions
Lab Performance		
Followed procedure correctly without depending too much on instructor or lab partner. Safety and proper waste disposal procedures observed Work space and glassware was cleaned up	3	
Lab Report		
Part A (data recorded with correct sig figs and units, calculations shown clearly, all questions answered)	4	
Part B (data recorded with correct sig figs and units, calculations shown clearly, all questions answered)	3	
Part C (data recorded with correct sig figs and units, calculations shown clearly, all questions answered)	3	
Part D (data recorded with correct sig figs and units, calculations shown clearly)	2	
Post Lab: Question 2 (work shown in detail with units)	1	
Post Lab: Question 3 (work shown in detail with units)	2	
Post Lab: Question 4 (work shown in detail with units)	2	
Total	20	

Subject to additional penalties at the discretion of the instructor.

Measurements and Conversion: Data Sheet

<u>Include the proper units</u> for all measurements and **<u>show all your work</u>** for any calculations. Report your answer to the correct number of significant figures.

A. Measuring Length

Mark Increments What do the smallest marks on the ruler go up by in cm?	**Estimated Digit** What place should be estimated?	**All measurements made on this ruler should have…**
		_____decimal places

Fill in the table being careful to use the appropriate amount of digits for each measurement or calculation.

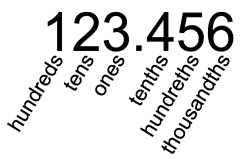
Letter on wooden block: ____	measurement	# of sig figs
length	cm	
width	cm	
height	cm	
Volume (l x w x h)	cm^3	

Height of beaker in centimeters (A) _____ Height of beaker in inches (to nearest 1/16) (B) _____

Measured conversion factor (divide (A) / (B)) _____cm = 1 in

How does this compare to the actual conversion value (2.54 cm = 1 in)? Why might it be different?

B. Measuring Volume



Graduated Cylinder	**Mark Increments** What place do the smallest marks go to? (ones, tenths, hundredths, etc)	**Estimated Digit** What place should be estimated?	**Measurement.** Record the volume of water to the correct place.
10 mL	tenths (.1)		
100 mL			
1000 mL			

C. Measuring Mass

Item	measured mass	Convert to… (show work and units, round for SF)
wood block		x _____lb = **lb** g
beaker		**kg**
sand		**µg**

D. Measuring Temperature

Substance	Temperature	Convert to … (show work)
water		**K**
Ice water		**K**

For Q1- Q3, show work in detail with units and round for SF. <u>Use only the conversions provided in this lab document</u>.

Q1. Convert 85 mg to pounds (lb)

$$85.0\ \text{mg} \times \frac{\text{g}}{\text{mg}} \times \frac{\text{lb}}{\text{g}} =$$

Q2. Convert 985 mL to gal

Q3. Convert 1.76×10^6 cm to miles