CH 114 Introduction to the Metric System and Unit Conversions

As mentioned in class, the metric system is the unit of choice in science labs. The metric system uses prefixes combined with fundamental or base units. The fundamental unit for length is the meter. The fundamental unit for mass is the gram and the fundamental unit for volume is the liter. The metric system uses other fundamental units as well but the gram, liter and meter are the three main units we will be working with this term. A subunit forms when a prefix combines with a fundamental unit. A subunit is chosen based on the size of the measurement. For example, the milli prefix represents 1/1000 or 0.001 base units. One meter contains 1000 millimeters or 1 millimeter equals 0.001 meters. If you were measuring the distance between your house and the college, millimeters would not be an appropriate unit to use because they are so small. Instead, using meters or more likely kilometers would be a more appropriate choice. Some of the more common prefixes (ie the ones we will use in class) are listed below:

Prefix	Symbol	Numerical Value
kilo-	k	1000
centi-	c	1/100 or 0.01
milli-	m	1/1000 or 0.001
nano	n	$1/1*10^{9}$ or $1*10^{-9}$

Units of measurement are abbreviated using symbols for both the prefix and the fundamental unit. A meter is represented by the symbol m, a liter is represented by L and a gram is represented by g.

Often the unit of a measurement will need to be converted into another unit (either a metric unit or an English unit used in the United States). Cookbooks represent an excellent source of unit conversions. Listed below are some common conversions. You will not need to memorize any conversions in this course. If you can't find a conversion you need, please ask.

Helpful Unit Conversions for CH 114

1 inch = 2.54 centimeters   1 meter = 39.87 inches
1 foot = 30.5 cm   1 liter = 1.06 quarts
1 pound = 453.6 grams   1 kilogram = 2.2 lbs
1 ounce = 28.35 g   1 qt = 0.94 L
1 fluid ounce = 29.6 mL

Units can be converted using a process called the factor labeled method. This problem solving skill is helpful for familiar unit conversions like these but can also be used for conversions between units we aren't as familiar with. In order to convert the given units to the desired units we need to multiply the given units by a conversion factor:

given units * conversion factor = desired units

Notice that all of the unit conversions listed above include two different units and therefore we can treat each as a fraction where we decide which unit goes in the numerator and which unit goes in the denominator. We multiply numbers and units in the numerator and divide by numbers and units in the denominator.

given units * $\dfrac{\text{desired units}}{\text{given units}}$ = desired units

The given units in the above generic example cancel out (because we are dividing by the given units in the denominator of the unit conversion) leaving the desired units. Let's look at a more specific example.

Example: One of the footprints from the unknown animal or bird was measured to be 0.50 cm, how long was the print in millimeters?

This question is asking us to convert centimeters to millimeters so we need to look up (or know) that conversion. From the chart above, we know there are 100 cm in 1 m and 1000 mm in 1 m so that means there are 10 mm in 1 cm (we could also count the small gradations on the ruler too). Our given unit is cm and our desired unit is mm.

0.50 cm * $\dfrac{10 \text{mm}}{1 \text{ cm}}$ = 5.0 mm

The cm units cancel out top and bottom and we are left with only mm. We can check our work by inverting the unit conversion:

0.50 cm * $\dfrac{1 \text{ cm}}{10 \text{ mm}}$ = 0.05 cm^2/mm

Notice the mess of units we got from this set up. Instead of the cm canceling out, they are multiplied together. Doing the math with your units, as well as the numbers is an excellent way to check your work and be confident you solved the question correctly.

What happens when a single unit conversion isn't available? Now we need to string together two or more unit conversion as shown below.

Example: A bullet slug has a mass of 0.75 ounces. What is the mass of the slug in kilograms?

From the charts above we know that 1 ounce = 28.35 g and 1000 g = 1kg. Our given unit is ounces and our desired unit is mg.

0.75 oz * $\dfrac{28.35 \text{g}}{1 \text{ oz}}$ * $\dfrac{1 \text{ kg}}{1000 \text{ g}}$ = 0.021 kg

Being able to convert units is a necessary and important problem solving skill in chemistry (even though it seems more like math). The following exercises have been provided for you to practice and gain confidence.

Exercises: Please show your work for each of the following.

1) The distance from New York City to Auckland, New Zealand is 14397 km. Express this distance in meters in scientific notation with **three** significant figures.

2) An extra-strength aspirin tablet contains 0.500 g of aspirin. How many grains is this? 1 grain = 64.8 mg

3) Football in Canada is played on a field 110.0 yards in length. What is the length of this field in meters? 1 yard = 3 feet, 12 inches = 1 foot and 2.54 cm = 1 inch.

4) Electromagnetic radiation having a wavelength of 674 nm falls in the red region of the visible spectrum. What is the length of the radiation in centimeters? 1 nm = $1*10^{-9}$ m