**Answer Key to Unit Conversions Problem Set**

There are a few concepts that are useful in performing any unit conversion. The most important of these is to make sure the units cancel out in the problem setup. Gather the conversion factors you need and “map out” the conversion. The units will guide you on how to set up the problem. If you already haven’t done so, memorize the meanings (power of 10) for each of the metric prefixes. The metric prefixes are exact numbers, so they do no limit your significant figures. A “1” in any conversion factor is also exact. For English/metric conversions, only the length conversion, 2.54 cm = 1 in, is exact. For all other conversion factors, one needs to use a conversion factor expressed to the number of significant figures required. One should not limit the number of significant figures in an answer based on the conversion factor.

1. a. When performing a metric to metric unit conversion, place the “1” with the unit with the prefix and place the meaning of the prefix as a power of 10 next to the base unit. You will need a conversion from milligrams to grams. The gram unit is the base unit; it has no prefix. If you know the meaning of the prefix, milli-, you can easily set up the problem. The prefix, milli-, means 10-3. Thus, 1 milligram is 10-3 gram. Here is the setup showing how the units cancel:

$$15.3 mg x \frac{1 x 10^{-3} g}{1 mg} = 0.0153 g$$

 b. It is not worthwhile memorizing every combination of conversion factors for the metric prefixes. The simpler route is to convert the original prefixed unit to the base unit and then to the prefixed unit you need. In this case, convert kilometers to meters and then meters to centimeters. Let the units help you set up the problem:
$$0.1455 km x \frac{1 x 10^{3} m}{1 km} x \frac{1 cm}{1 x 10^{-2} m} = 1.455 x 10^{4} cm$$

 c. Covert milligrams to grams then to nanograms:

$$35.78 μg x \frac{1 g x 10^{-6} g}{1 μg} x \frac{1 ng}{1 x 10^{-9} g} = 3.578 x 10^{4} ng$$

 d. In this problem, one must convert two sets up units one at a time. It doesn’t matter which unit is converted first. Arbitrarily, the length units, centimeters is converted to micrometers; then the time units, seconds are converted to hours. If one knew that 3600 seconds equals 1 hour, one step could have been saved.
$$\frac{55.8 cm}{s} x \frac{1 x 10^{-2} m}{1 cm} x \frac{1 μm}{1 x 10^{-6}} x \frac{60 s}{1 min} x \frac{60 min}{1 hr} = 2.01 x 10^{9} μm/hr$$

 e. When exponents are needed for a conversion, set up the conversion factor in one dimension first (without the exponent) and then raise all the components of the conversion factor to the power needed. In this case, first convert grams to kilograms, then centimeters to meters and raise all the components in the length conversion to the third power:

$$\frac{2.7 g}{cm^{3}} x \frac{1 kg}{1 x 10^{3} g} x \frac{1^{3} cm^{3}}{(1 x 10^{-2})^{3} m^{3}} = 2.7 x 10^{3} kg/m^{3}$$

2. The United States is one of few countries in the world that is not metric, hence we have to be able to convert our English units to metric units and vice versa. Common units converted are length, mass and volume. It is convenient to learn one conversion for each of these variables to be able to bridge the two systems. (Personally, this author prefers the metric system and wishes the US would go metric.) For length, 2.54 cm = 1 in (an exact conversion), for mass, 453.6 g = 1 lb, and for volume, 0.9464 L = 1 qt are conversions you might want to commit to memory for convenience.

 a. Use the conversion factor, 453.6 grams equal to 1 pound and let the units set up the problem:

$$145 lb x \frac{453.6 g}{1 lb} = 6.58 x 10^{4} g$$

 b. Convert milliliters to liters then to quarts:

$$34.65 mL x \frac{1 x 10^{-3} L}{1 mL} x \frac{1 qt}{0.9464 L} = 3.661 qt$$

 c. Convert each unit one at a time. Another convenient conversion for length is 1.609 km = 1 mile. As stated in a previous problem, there are 3600 seconds in 1 hour:

$$\frac{55 mi}{hr} x \frac{1.609 km}{1 mi} x \frac{1 hr}{3600 s} = 2.5 x 10^{-2} km/s$$

 d. Convert kilograms to grams to pounds. Next, convert centimeters to inches, squaring all the components in the conversion factor and then inches to feet, once again squaring all the components in the conversion factor:

$$\frac{7.1 kg}{cm^{2}} x \frac{1 x 10^{3} g}{1 kg} x \frac{1 lb}{453.6 g} x \frac{2.54^{2} cm^{2}}{1^{2} in^{2}} x \frac{12^{2} in^{2}}{1 ft^{2}} = 1.5 x 10^{4} lb/ft^{2}$$

 e. Convert one unit at a time. Don’t forget to cube the length conversion factors.

$$\frac{5.6 x 10^{3} ton}{mi^{3}} x \frac{2000 lb}{1 ton} x \frac{453.6 g}{1 lb} x \frac{1 Mg}{1 x 10^{6} g} x \frac{1^{3} mi^{3}}{1.609^{3} km^{3}} = 1.2 x 10^{3} Mg/km^{3}$$

3. The easiest equation for the temperature conversion between Celsius and Fahrenheit is:

°F = 1.8°C + 32

Thus, you can rearrange this equation and solve for the Celsius temperature:

$$℃ = \frac{℉ - 32°}{1.8}$$

This eliminates the need to recall whether to use 9/5 or 5/9 in other temperature conversion equations you may have encountered in the past, such as °F = (9/5)°C + 32° or °C = 5/9(°F – 32°). Also, the “1.8” and 32° are exact and so they won’t impact significant figures.

The Kelvin scale, also called the absolute temperature scale, is based on the premise that there is an absolute zero temperature. The Kelvin temperature is calculated from the Celsius temperature according to the equation:

K = °C + 273.15

If you are starting with a Fahrenheit temperature, convert to Celsius first, then to the Kelvin scale.

 a.
$$℃ = \frac{℉ - 32°}{1.8} = \frac{45.3° - 32°}{1.8} = 7.4℃ $$

 b.
$$℉ = 1.8℃ + 32 = 1.8(-2.3 ℃) + 32° = 27.9℉$$

 c.
$$K = ℃ + 273.15 = 341℃ + 273.15 = 614 K$$

 d. Rearrange the equation to solve for Celsius:

$$℃ = K - 273.15 = 188 K - 273.15 = -85 ℃$$

 e. Convert Kelvin temperature to Celsius, then covert the Celsius temperature to Fahrenheit:

$$℃ = K - 273.15 = 456 K - 273.15 = 183 ℃$$

$$℉ = 1.8℃ + 32 = 1.8(183 ℃) + 32° = 361℉$$

4. Map out the conversion first, then carry out the steps.

 a. From sizzles, you can find squeaks;from squeaks you can find clangs:

$$2 sizzles x \frac{2 squeaks}{5 sizzles} x \frac{7 clangs}{2 squeaks} = 2.8 clangs$$

 b. From squeaks, you can find clangs; from clangs you can find pings:

$$34 squeaks x \frac{7 clangs}{2 squeaks} x \frac{1 ping}{4 clangs} = 29.8 pings $$

 c. From sizzles, go to squeaks; from squeaks, go to clangs; from clangs, go to pings; from pings, go to blinks:

$$15 sizzles x \frac{2 squeaks}{5 sizzles} x \frac{7 clangs}{2 squeaks} x \frac{1 ping}{4 clangs} x \frac{11 blinks}{6 ping} = 9.6 blinks$$