A Short Guide to Unit Conversions

Converting between units is a very important skill for working in the physical sciences and for making comparisons of everyday quantities. While it is not terribly difficult, it can be a little bit tricky until you get the hang of it, and some people tend to make it more complicated than it really is.

Conceptually, it is important to think of a unit as a way of measuring something. Try to find a conversion factor where one unit A is equal to some number of unit B. That is to say, ask yourself, "If I have one unit of A, how much is that in unit B?" Out of this relation, build a ratio such that the units you want to get rid of cancel out when you multiply your answer by this conversion factor (You will be able to cancel if you have the same unit in both the numerator and the denominator). That is to say, treat the unit labels as if they were genuine algebraic symbols (i.e., variables).

You may have to use several conversion factors in order to reach the final answer, but this neat "factor-label" method will allow you to write the equation on one single line. Just make sure that you have the correct ratios and that all the unit symbols cancel out.

Example:

As an example, suppose you know that the distance to Andromeda galaxy is 2.1×10^{22} cm. You would like to convert this answer to parsecs. You know the following relations between relevant units:

$$
\begin{aligned}
1\,\text{cm} &= 0.01\,\text{m} \\
1\,\text{light} - \text{year} &= 9.5 \times 10^{15}\,\text{m} \\
1\,\text{parsec} &= 3.2\,\text{light} - \text{years}
\end{aligned}
$$

These relations show you the way to go: you will convert centimeters to meters, then meters to light-years, and finally light-years to parsecs. One way of handling this conversion is to do exactly that, one step at a time.

Alternatively, you can use the "factor-label" method as follows: First, start off with the distance in cm and multiply it by the conversion factor of m to cm. Make sure that the ratio is oriented so that the "cm" symbols cancel out and you're left with an answer in meters (i.e. the "cm" of the fraction should be in the denominator). Now repeat the procedure with the conversion factors from meters to light years and from light-years to parsecs, each time multiplying the rest of the equation by a new ratio:

$$
2.1 \times 10^{22}\,\text{cm} \times \left(\frac{0.01\,\text{m}}{1\,\text{cm}} \right) \times \left(\frac{1\,\text{light} - \text{year}}{9.5 \times 10^{15}\,\text{m}} \right) \times \left(\frac{1\,\text{parsec}}{3.2\,\text{light} - \text{years}} \right) = 6.9 \times 10^3\,\text{parsec}
$$

It is really that simple! You simply have to make sure that the units cancel each other out properly to leave you with units you are looking for.

You might ask: "How can this work?" Well, notice that since 1 centimeter is equal to 0.01 meter, the ratio of these two quantities which constitutes the conversion factor is really equal to "one." Hence, by multiplying by this factor you do not affect the value of the answer, you are merely changing units (as wanted!).