A quick and dirty guide to dimensional analysis

First and foremost, dimensional analysis (along with the majority of chemistry) is just clever application of algebra. To be successful in using dimensional analysis, students must be competent in addition/subtraction, multiplication/division, powers, and parentheses. Basically, PEMDAS is back and will actively be put to use.

Dimensional Analysis is the analysis of relationships between different physical quantities, by first identifying unifying base qualities of the measurements in question. Effectively, if given a measurement and you don't like the units given, how do you change the units without changing the quantity? Can we convert miles per hour to meters per second? The velocity will remain unchanged, but the measurement will. Dimensional Analysis can be used to convert between compounds in a chemical reaction by utilizing any quantitative measurement of one, and relating it to another via a balanced reaction.

The steps to solving a dimensional analysis problem are as follows:

1. **Identify the measurement you are given**. What is it? Is it a distance? An amount of something? Time? The velocity of a car on the highway, the mass of a compound consumed in a reaction, all are valid.

2. **Identify what unit(s) you are trying to obtain**. What is the question asking for?

3. **Outline how to convert one unit to another**. Are there intermediate units that you can use to convert one to another? What conversions are you given? If I was given kilometers and wanted centimeters, are there intermediate units that I can convert to each? Often, you must make a unit conversion form a balanced reaction or from the periodic table itself. If you are given a measurement that has two different base qualities such as (amount/mass), (distance/time), make two outlines for each base quality.

4. **Assemble your equation**. List your given and add your conversions as you outlined in step 3.

5. **Ensure that every unit cancels out, excluding the desired units**. Remember that equal values in numerators and denominators effectively cancel out, the same principle applies to units. A ratio of values with the same unit becomes a unitless ratio.

6. **Solve the algebraic expression that you created.** Multiply numerators, divide denominators. Write the remaining units which should exactly match your desired units. Don’t forget to track significant figures!

7. A car is driving 65 miles/h. What is its velocity in m/s?

1. We are given miles per hour
2. We need meters per second
3. We need to convert distance and time. Distance is in miles, which can be converted to feet, to inches, to centimetres, then to meters. Time can be converted from hours to minutes to seconds.
4. Assemble the equation.

$$\frac{65\ miles}{hour}\left(\frac{5280\ ft}{1\ mile}\right)\left(\frac{12\ in}{1\ ft}\right)\left(\frac{2.54\ cm}{1\ in}\right)\left(\frac{1\ m}{100\ cm}\right)\left(\frac{1\ hour}{60\ minutes}\right)\left(\frac{1\ minute}{60\ s}\right)$$

5. Every unit that is not wanted cancels out at some point with an equivalent value in the numerator or denominator
6. All values in the numerator are multiplied, while values in the denominator divide. The result is 29 m/s

Traveling at 20 miles/hour, how many feet can you travel in 22 minutes?

How many years is 2.05×10^5 seconds?

In Raiders of the Lost Ark, Indiana Jones tried to remove a gold idol and replace it with a bag of sand. If the idol has the mass of 2.00kg, how many liters of sand did he need, if the density of sand is 3.00g/cm^3?

Challenge:

You attempt to dissolve silver in a nitric acid solution, however solid silver remains. If the remaining silver weighs 38.421g, how many mL of nitric acid solution will be needed assuming the solution is 3M? Write a balanced chemical reaction