UNIT CONVERSIONS

Unit conversions are merely a way of changing the measuring device for a particular value. Each value has units measured in terms of distance, area, volume, time, rate, etc. A unit change does not change the value itself, so the unit conversion process involves multiplying by 1 only.

In order to complete unit conversions, a conversion factor must be used. In order to convert from yards to feet, the ratio must be known. This ratio can be written in three different ways.

Conversion Factor	Unit Fraction Number 1	Unit Fraction Number 2
1 yard = 3 feet	$\dfrac{1\,\text{yard}}{3\,\text{feet}} = 1$	$\dfrac{3\,\text{feet}}{1\,\text{yard}} = 1$

Many times a conversion list or conversion table will give you just a numeric conversion factor. It can be written either as 1 yard = 3 feet, or as 0.3333 yard = 1 foot.

When doing unit conversions, the thought process is best described as: What units do I have now and what units do I want to have? The idea is to write what you have as a fraction and multiply by unit fractions until the units you want are obtained. Units will divide out just like numbers in this system. Here are a few basic examples, followed by some more complicated ones.

Example 1 **How many minutes are in 3 days?**

What we are starting with is 3 days. The conversions used will move days into hours, then hours into minutes. The conversion factors are 1 day = 24 hours, and 1 hours = 60 minutes. Remember from above that there were two unit fractions. You must choose which one to use in this problem to eliminate units. Since we are starting with days, we will want to eliminate days.

My unit conversions will be $\dfrac{24\,\text{hours}}{1\,\text{day}} = 1$ and $\dfrac{60\,\text{minutes}}{1\,\text{hour}} = 1$.

Then

$$3\,\text{days} = \left(\frac{3\,\text{days}}{1}\right) \cdot \left(\frac{24\,\text{hours}}{1\,\text{day}}\right) \cdot \left(\frac{60\,\text{minutes}}{1\,\text{hour}}\right) = \left(\frac{3\,\text{days}}{1}\right) \cdot \left(\frac{24\,\text{hours}}{1\,\text{day}}\right) \cdot \left(\frac{60\,\text{minutes}}{1\,\text{hour}}\right) = 4320\,\text{minutes}$$

| Starting value | Multiply by unit conversions | Eliminate common units | Final value |

Therefore, 3 days = 4320 minutes.

Example 2 **How many teaspoons are in a gallon?** (probably need a conversion table here)

1 gallon = 4 quarts, 1 quart = 2 pints, 1 pint = 2 cups, 1 cup = 16 tbsp, 1 tbsp = 3 tsp

$$1\,\text{gallon} = \left(\frac{1\,\text{gal}}{1}\right)\left(\frac{4\,\text{qt}}{1\,\text{gal}}\right)\left(\frac{2\,\text{pint}}{1\,\text{qt}}\right)\left(\frac{2\,\text{cups}}{1\,\text{pint}}\right)\left(\frac{16\,\text{tbsp}}{1\,\text{cup}}\right)\left(\frac{3\,\text{tsp}}{1\,\text{tbsp}}\right) = 768\,\text{tsp}$$

| Starting Value | Multiply by unit conversions and eliminate common units | Final value |

Therefore, 1 gallon = 768 teaspoons.

Example 3 **A bullet is traveling at 2400 feet per second. How fast is this in miles per hour?**

Conversions needed: 1 mile = 5280 feet, 1 hour = 60 minutes, 1 minute = 60 seconds.

$$2400 \text{ feet in one second} = \left(\frac{2400 \text{ ft}}{1 \text{ sec}}\right)\left(\frac{60 \text{ sec}}{1 \text{ min}}\right)\left(\frac{60 \text{ min}}{1 \text{ hr}}\right)\left(\frac{1 \text{ mile}}{5280 \text{ feet}}\right) = \frac{8640000 \text{ mile}}{5280 \text{ hour}} \approx 1636 \text{ mph}$$

Example 4 **A man is laying carpet in a rectangular room with dimensions of 10 feet by 12 feet. How many square yards of carpet are needed?**

First, calculate the area of the carpet in square feet: $10 \text{ ft} \cdot 12 \text{ ft} = 120 \text{ ft}^2$. Since we must convert from square feet, we will need to square the conversion factor or repeat twice depending on your preference!

$$120 \text{ ft}^2 = \left(\frac{120 \text{ ft}^2}{1}\right)\left(\frac{1 \text{ yard}}{3 \text{ feet}}\right)^2 = \left(\frac{120 \text{ ft}^2}{1}\right)\left(\frac{1 \text{ yd}^2}{9 \text{ ft}^2}\right) = \frac{40}{3} \text{ yd}^2 \approx 13.3 \text{ yd}^2$$

WARNING: The conversion factor must be squared, cubed or otherwise raised to a power to eliminate units which are raised to powers. The common mistake is to divide by 3, which would leave you with 40 yd^2 (incorrectly). This would leave you with a lot of extra carpet. Notice the units at the end if you calculate incorrectly.

$$120 \text{ ft}^2 = \left(\frac{120 \text{ ft}^2}{1}\right)\left(\frac{1 \text{ yard}}{3 \text{ feet}}\right) = \left(\frac{120 \text{ ft} \cdot \text{ft}}{1}\right)\left(\frac{1 \text{ yd}}{3 \text{ ft}}\right) = 40 \text{ yd} \cdot \text{ft}$$

These final units are NOT what was asked for (plus they don't make a lot of sense), so more conversions would be needed.

Example 5 **A car wheel has a radius of 10 inches and it rotates 4 times in one second. Determine how fast the car is traveling in feet per second and miles per hour.**

Here we need to know the distance the wheel travels in one revolution/rotation, so we must use the circumference. Circumference is the distance around a circle, which would be the same as the distance traveled by rolling the circle one time. $C = 2\pi r = 2\pi \cdot 10 = 20\pi$. Thus 1 revolution = 20π inches.

$$4 \text{ revolutions in one second} = \left(\frac{4 \text{ rev}}{1 \text{ sec}}\right)\left(\frac{20\pi \text{ in}}{1 \text{ rev}}\right)\left(\frac{1 \text{ foot}}{12 \text{ in}}\right) = \frac{20\pi \text{ feet}}{3 \text{ seconds}} \approx 21 \text{ fps}$$

Using the same information from example 3, we could quickly convert this to mph.

Example 6 **A chemist would like to know the density (in g/ml) of a substance which weighs 13 ounces and displaces 7.4 fluid ounces of water.**

Conversion units: 1 fl. oz. = 29.574 mL, 1 oz. = 28.35 grams.

$$13 \text{ ounces in 7.4 fluid ounces} = \left(\frac{13 \text{ oz}}{7.4 \text{ fl oz}}\right)\left(\frac{1 \text{ fl oz}}{29.574 \text{ mL}}\right)\left(\frac{28.35 \text{ g}}{1 \text{ oz}}\right) \approx 1.684 \text{ }^{g}\!/_{mL}$$

In many of these cases, a good conversion table is needed to complete these conversions, and the accuracy of your final solution will completely depend on the accuracy of the conversion table values.