Dimensional Analysis

During your study of engineering, you will solve countless equations and be required to determine both the numerical value and the units or dimensions of a variable in an equation. You have had considerable experience in determining the numerical value in many of your math classes. Determining the proper units or dimensions by using dimensional analysis is less familiar to many students. Dimensional analysis offers the following advantages:

- It is a useful method for determining the correct units of a variable in an equation.
- It allows you to check the correctness of an equation or a solution by checking to see if your answer has the appropriate units.

Examples

Example 1 - Convert 6 inches into the appropriate number of centimeters.

The conversion factor from centimeters (cm) to inches (in) is1 in = 2.54 cm, therefore

$$6\ \cancel{in} \times \frac{2.54\ cm}{1\ \cancel{in}} = 15.24\ cm$$

Example 2 – Determine the density of a plastic cube, expressed in g/ml, whose dimensions are as follows:

L = W = H = 0.5 in
M = 2.7 g

Density (D) = mass (M) / Volume
Volume(cube) = L x W x H
1 in = 2.54 cm
1 cm^3 = 1 ml

$$D = \frac{M}{V} = \frac{2.7\ g}{(0.5\ \cancel{in})(0.5\cancel{in})(0.5\cancel{in})} \times \frac{1\cancel{in}}{2.54\ cm} \times \frac{1\cancel{in}}{2.54\ cm} \times \frac{1\ \cancel{in}}{2.54\ cm}$$

$$D = \frac{2.7\ g}{(0.5)^3\ (2.54cm)^3}$$

$$D = 1.32\ g/cm^3 \times \frac{1\ cm^3}{1\ ml} = 1.32\ g/ml$$

Rules to remember:

- Only quantities of the same dimension may be added, subtracted, compared, or equated.
- When quantities, those with like or unlike dimensions, are multiplied or divided, their dimensional symbols are likewise multiplied or divided.
- When dimensioned quantities are raised to a rational power, the same is done to the dimensional symbols attached to those quantities.

References:
http://www.physics.uoguelph.ca/tutorials/dimanaly/

http://en.wikipedia.org/wiki/Dimensional_analysis