Solving Problems with Dimensional Analysis (Factor Label Method)

"Dimensional" refers to units and "dimensional analysis" refers to the analysis of a problem by looking the units in the problem.

These are the steps I recommend for this method:

1. Read the problem carefully and determine what units the answer should have.
2. Write "x" followed by the unit of the answer.
3. Follow this with an equal sign: "="
4. Next write the number and units on which the answer is dependent, but keep in mind that if the unit you are looking for (the unit in the answer) is not fractional, you should have it equal to a number with fractional units. (e.g. g/mL is a fractional unit. "g" is not.)
5. Next write conversion factors such that the units cancel out leaving you with only the units you are aiming for. Cross out the units that canceled.
6. **Check** the answer for correct # of sig. fig. and the units are what you aimed for.
7. **Check** whether it is appropriate/necessary to use scientific notation.

PROBLEM 1: What is the volume of 3.78 g of alcohol if the density of the alcohol is 1.10 g/mL?
Here is how the problem is analyzed, step by step.

1. The answer should have a unit of volume, such as mL.
2. x mL
3. x mL =
4. x mL = 3.78 g and not x mL = 1.10 g/mL because "mL is not fractional and g/mL is.
5. $\text{x mL} = 3.78 \cancel{\text{g}} \left(\frac{1 \text{ mL}}{1.10 \cancel{\text{g}}} \right) = 3.4363636... \text{ mL}$
6. Answer is 3.44 mL.

You are not expected to write out the 6 steps, but just the set up and the answer:

$$\text{x mL} = 3.78 \cancel{\text{g}} \left(\frac{1 \text{ mL}}{1.10 \cancel{\text{g}}} \right) = 3.4363636... = 3.44 \text{ mL}$$

In the case where more than one conversion is necessary, do not do each conversion separately. Instead combine the setup into one as follows:

PROBLEM 2: What is the distance of 4271 feet in units of millimeters?

$$\text{x mm} = 4271 \cancel{\text{ft}} \left(\frac{12 \cancel{\text{in}}}{1 \cancel{\text{ft}}} \right) \left(\frac{2.54 \cancel{\text{cm}}}{1 \cancel{\text{in}}} \right) \left(\frac{10 \text{ mm}}{1 \cancel{\text{cm}}} \right) = 1.302 \text{x} 10^{6} \text{mm}$$

Here is a problem involving fractional units.

PROBLEM 3: The density of a solid is 4.7 g/cm^3. What is it in ounce per qt?
Analysis:
The conversion factors we need involve changing g to oz, cm^3 to mL, mL to L, L to qt.

Solution:

$$x\ \frac{\text{oz}}{\text{qt}} = \frac{4.7\ \cancel{g}}{1\ \cancel{cm^3}}\left(\frac{1\ \cancel{lb}}{454\ \cancel{g}}\right)\left(\frac{16\ \text{oz}}{1\ \cancel{lb}}\right)\left(\frac{1\ \cancel{cm^3}}{1\ \cancel{mL}}\right)\left(\frac{10^3\ \cancel{mL}}{1\ \cancel{L}}\right)\left(\frac{0.946\ \cancel{L}}{1\ \text{qt}}\right) = 1.6\text{x}10^2\ \text{oz/qt}$$

[There is a tutorial on "Practice Problems on Unit Conversion." Return to my HomePage.]
[Extra Practice: Brady & Senese 5th Ed, p.31 #40-55.]