Conversions

two methods are generally used...
   (1) proportions
   (2) factor label a.k.a. unit analysis

some people think proportions are easier...

How many centimeters in 2.00 mile?

proportions

$$\frac{x \text{ feet}}{5280 \text{ ft}} = \frac{2.00 \text{ mile}}{1 \text{ mile}}$$

solve for x...

$$x = 10560 \text{ feet}$$

next a proportion to switch to inches...

next a proportion to switch to cm... but doing it this way I will be old and gray so...

factor label

$$2.00 \text{ mile} \times \frac{5280 \text{ ft}}{1 \text{ mile}} \times \frac{12 \text{ inches}}{1 \text{ ft}} \times \frac{2.54 \text{ cm}}{1 \text{ inch}} = 321{,}868.8 \text{ cm}$$

$$= 3.22 \times 10^5 \text{ cm}$$

Why does factor label work? Well, all you are really doing is multiplying by 1....watch

What about significant figures here?

2.00 and 12 have 3 and 2 sig figs respectively, and 1 has only 1 sigfig. So why does the answer have three sig figs?

The answer is that 12 and 1 are exact numbers, and have as many significant figures as are needed.

Determine the number of cubic feet in 1.5 m^3

$$1.5 \text{ m}^3 \times \frac{(100 \text{ cm})^3}{(1 \text{ m})^3} \times \frac{(1 \text{ in})^3}{(2.54 \text{ cm})^3} \times \frac{(1 \text{ ft})^3}{(12 \text{ in})^3} = 52.972 \text{ ft}^3$$

$$= 53 \text{ ft}^3$$

When you convert units you have to make certain that you convert all of the units. The volume unit is not m it is m^3. You can think of this way: to determine the volume of a cube you must multiply the length by the width by the height. If you converted each measurement before determining the volume, you would perform three conversion. So, to convert the volume unit you actually have to convert three length units.
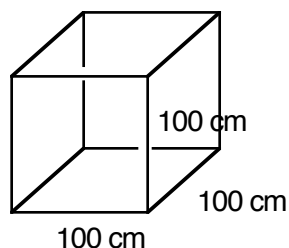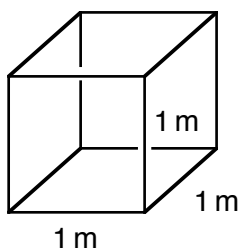
Determine the number of L in 350 in^3.

$$350 \text{ in}^3 \times \frac{(2.54 \text{ cm})^3}{(1 \text{ in})^3} \times \frac{1 \text{ mL}}{1 \text{ cm}^3} \times \frac{1 \text{ L}}{1000 \text{ mL}} = 5.735 \text{ L}$$

$$= 5.7 \text{ L}$$

or

$$350 \text{ in}^3 \times \frac{(2.54 \text{ cm})^3}{(1 \text{ in})^3} \times \frac{1 \text{ L}}{1000 \text{ cm}^3} = 5.735 \text{ L}$$

$$= 5.7 \text{ L}$$

Derived units

are simply units created by combining other units like...

Density– is g of material in 1 cm^3 (or mL)

%—Percent: number of parts of one constituent in 100 parts of the whole.

Percent is not enough information to make a valid unit. The unit of measure must be specified such as percent volume, or percent weight. (If only % is listed the unit is assumed to be % weight.)

usually written   % wt.   and   % vol.

ppm,ppb: parts per million, and parts per billion. These units are enough: translate to # of particles per million particles.

Density tells us how much (grams) material is in a certain
   volume (mL)
        convert from volume of material to mass of material or visa versa.

% vol. tells us how much of the whole object is one material in
   terms of volume.

        12 % vol. of a bottle of wine is alcohol by volume.
             180 mL wine is 12 % alcohol or 22 mL of alcohol

% wt. tells us how much of the whole object is one material in
   terms of mass.

        37 % wt. of a bottle of aqueous hydrochloric acid is hydrochloric
        acid
             in 100 g of HCl(aq) 37 of those grams are HCl

Using derived units to perform conversions

**derived units are great for converting between different types
of measurements
like mass to volume or volume to mass**

How much alcohol (in grams) is in a bottle of chardonnay (0.750 L). A dry chardonnay is typically labeled 13.5 % alcohol by volume.

so, we need to go from vol. wine to amount of alcohol in grams....personally, I solve problems **backwards**....and then crunch numbers forwards.

I need grams of alcohol....(1st question) how can I get grams of alcohol from volume of wine? I can't.

Can I get grams of wine from volume of wine?

      Not without knowing the density of the wine.
      Can I look up the density of wine in a handbook? No.

Can I get volume of alcohol from volume of wine?

      Yes, I know the percent composition by volume of the wine.

Now that I know the volume of the alcohol in the wine, can I convert the volume of alcohol to gram of alcohol?

      Density is good for converting between g and mL. Do I know the density of alcohol? No. Can I look it up in a book? Yes.

OK, I can go from vol wine to vol alcohol using % vol, and then I can you from vol of alcohol to g of alcohol using density.

number crunch forwards (by the way...I converted cm³ to mL without writing that step down)

750 mL wine x <u>13.5 mL alcohol</u> x <u>0.794 g alcohol</u> = 80.39 g alcohol
             100 mL wine   1 mL

                                   = 80.4 g alcohol

Notice, when I write units not only do I write the measurement unit, but I also write the name of the material to which the unit refers. This will help keep you from using the wrong conversion factors.

$$750 \text{ mL wine} \quad \times \quad \frac{0.798 \text{ g ethanol}}{1 \text{ mL ethanol}}$$

The units "mL wine" and "mL ethanol" are not the same unit. Thus, they do not cancel out!