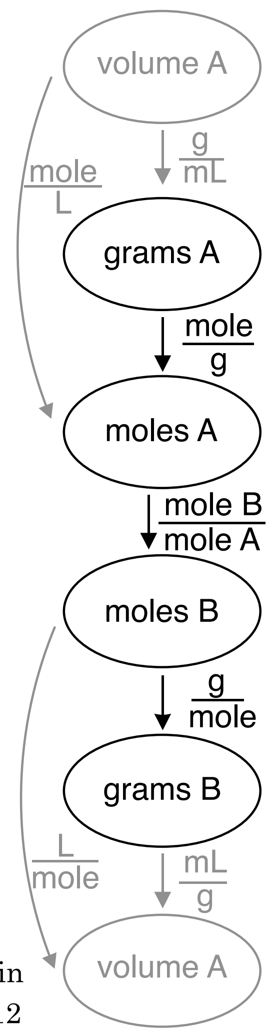
Chem 220 # Calculation Review Lisensky

Dimensional analysis is the technique of treating units as numbers for the purpose of solving problems. For mathematical purposes 1 ft means 1 × ft. (Numbers are multiplied by their units.) Write a ratio with one unit on bottom and another unit on the top. Insert numbers to make the top and bottom *equal* to use as a conversion factor.

- Words that mean divided: per, in a, is a, are a, goes with, equals, equivalent
- Recognize that there is a difference between $/lb and lb/$.
- Metric prefixes can be treated as independent units: $\frac{\text{milli}}{0.001}$ $\frac{\text{kilo}}{1000}$ $\frac{\text{centi}}{0.01}$
- Converting 6 m^2 to square ft requires using a conversion twice.
  $2 \times 2 = 2^2$ $\text{sec} \times \text{sec} = \text{sec}^2$ $3^2 \times 3^2 = 3^4$ $m^2 \times m = m^3$
- Always identify amount of what or moles of what. Having 2 mL or 4 grams or 3 mole is less meaningful than having 2 mL H_2O or 4 grams He or 3 mole C.

Most numerical chemistry problems involve

1. **converting from amounts to moles**
   Grams of solid converted to moles using formula mass: FM g/mole.
   Liters of liquid converted to grams using density in g/mL, then grams converted to moles using formula mass. The density of liquid water from 0 to 30°C is 1.00 g/mL.
   Liters of solution converted to moles using molarity. *Grams of solution* converted to grams dissolved using %, then grams converted to moles using formula mass.
   $$\text{Molarity} = \frac{\text{moles dissolved}}{\text{liters of solution}} = \text{M} \qquad \% = \frac{\text{g dissolved}}{\text{100 g solution}} \qquad \text{ppm} = \frac{\text{mg analyte}}{\text{kg sample}} \text{ or } \frac{\text{mg analyte}}{\text{L solution}}$$
   The number of moles or grams dissolved does not change upon dilution.
   Liters of gas converted to moles using $\frac{PV}{nT} = \frac{.082058 \text{ L atm}}{\text{mol K}}$.
2. **using stoichiometry information from formulas or balanced reactions**
   CO_2 means $\frac{\text{2 atoms O}}{\text{1 atom C}}$ or $\frac{\text{2 atoms O}}{\text{molecule } CO_2}$ or $\frac{\text{1 atom C}}{\text{2 atoms O}}$, etc.
   $2H_2 + O_2 \rightarrow 2H_2O$ means $\frac{\text{2 molecules } H_2}{\text{1 molecule } O_2}$ or $\frac{\text{2 molecules } H_2O}{\text{1 molecule } O_2}$, etc.
3. **converting from moles to amounts**
   Example: How many g Ag in 3.72 g Ag_2CO_3?
   $$3.72 \text{ g } Ag_2CO_3 \; \frac{\text{mol } Ag_2CO_3}{275.8 \text{ g } Ag_2CO_3} \frac{\text{2 mol Ag}}{\text{mol } Ag_2CO_3} \frac{\text{107.9 g Ag}}{\text{mol Ag}} = 2.91 \text{ g Ag}$$
   Example: 10.02 mL HCl is titrated with 0.1123 mol NaOH/L. The indicator changes color after addition of 42.34 mL NaOH. What is the mol HCl/L?
   a. Convert amount delivered from buret to moles
   b. Use stoichiometry of reaction: $1 \text{ HCl} + 1 \text{ NaOH} \rightarrow 1 \text{ NaCl} + 1 \text{ } H_2O$
   c. Moles/L wanted so take moles and divide by original liters.
   $$\frac{42.34 \text{ mL NaOH} \frac{\text{0.1123 mol NaOH}}{\text{L NaOH}} \frac{\text{1mol HCl}}{\text{1mol NaOH}}}{\text{10.02 mL HCl}} = 0.4745 \text{ mol HCl/L}$$



Symbols for molarity = mol/L

In analytical chemistry we need to make a distinction between how a solution is prepared and the species that are actually in the solution. We will use M for the "analytical concentration" (the total amount, or the recipe), and [ ] for the actual solution species concentration. Both are read as mol/L.

For example, in 1.0 M NaCl, the [NaCl] = 0.0, $[Na^+]$ = 1.0, and $[Cl^-]$ = 1.0, and in 1.00 M H_2SO_4, $[H_2SO_4]$ = 0.000, $[HSO_4^-]$ = 0.988, $[SO_4^{-2}]$ = 0.012, and $[H^+]$ = 1.012