Balancing Chemical Reactions (with extent(s) of reaction)
1- Write down and mole balance all chemical reactions, rewrite to minimize fractions.
2- Check to be sure that all reactants and products are include then make sure that no reactions are combinations of other reactions and eliminate the redundant reactions. If species are not dependant do not combine!
3- Convert feed (given) to molar ratios and determine the limiting reactant(s). An overall reaction may be useful here!
4- Write down the reactions with the limiting reactants as the top reactions.
5- Note any inerts and excess reagents, if specified.
6- Starting from the top, introduce extent of reaction variables (say X, Y, Z..) into the reactions. Assume the feed contains $v$ moles of the limiting reagents and $vX$ reacts. ($v$ is the stoichiometric coefficient).
7- Note the scaling for $v$ and write down the appropriate moles for all incoming species below their symbols!
8- Copy the variables below the first (nth) reaction into the second (n+1) reaction and introduce the next variable (Y, Z…, reaction extent) with the appropriate $v$'s below this reaction.
9- Correct the moles present (including all relevant variables) for all reactions and all species above the n+1 reaction.
10- Repeat steps 8 and 9 until all reactions and extents have been included.
11- Write down a Table of all species present. A column for the molar feed ratios, a column for the total concentrations of each species as functions of the extents and a similar column(s) for each species in each mixed phase.
12- Sum each column (including extents) to enable you to express molar fractions in each phase.
13- Note any limits to the combinations of extents (e.g., $X+Y < 2$ or $Y<X$ or…).
14- Express the given (known) concentrations or ratios of products/reactants or products/products as functions of the extents of reaction.
15- Solve the equations: look for simple substitutions and equalities.