YIELD OF CHEMICAL REACTIONS

- so far, we have assumed that every atom or molecule undergoes the chemical reactions we wrote down
  - would be an ideal case scenario, but rarely happens
  - this is called a "reaction goes to completion"
- in real life, most reactions do not only form the desired products
  - unreacted materials
  - side products
- the amount of product formed is called the YIELD of a reaction

PERCENT YIELD = (ACTUAL YIELD OF PRODUCT / THEORETICAL YIELD OF PRODUCT) x 100%

CALCULATING PERCENT YIELD

EX: if 10.6g of Na_2CO_3 react with 7.2g of HCl and form 2.0g CO_2, what is the percent yield of the reaction?

- start by writing the equation and balancing all coefficients
- figure out moles of reactants - use molar mass
- calculate theoretical yield using chemical stoichiometry

LIMITING REACTANTS

- the last slide introduced us to an important concept:
  - unless we mix exact stoichiometric amounts of chemical, there will be a LIMITING REACTANT
    - this is the chemical that has the lowest number for the quantity (number of moles coefficients)
    - the other reactant is the EXCESS REACTANT
      - there is more than enough of it
- we often use one reactant in excess to help the reaction go to completion
- very important for industrial scale reactions
  - especially if one reactant is cheap

REACTIONS WITH LIMITING AMOUNTS OF REACTIONS

Ex: at a high temp., ethylene oxide reacts with water to form ethylene glycol which is an automobile antifreeze and a starting material in the preparation of polyester polymers

$3C_2H_4(aq) + 5H_2O(l) >>>> 3C_2H_6O_2(l) + 2H_2O$

LIMITING REACTANT: ethylene oxide because it is completely used
EXCESS REACTANT: water because there are extra molecules on the solution(right) side of the equation that did not react

CALCULATIONS FOR LIMTING REACTANT PROBLEMS

Ex: how many grams of BaS can be formed through the reaction of 5.0g of Ba with 5.0g of Sulfur?

- assume that the limiting reactant is completely consumed

Ba(s) + S(s) >>>> BaS(s)

Formula Mass (Ba): 137.327 amu; Molar Mass (Ba): 137.327 g/mol
Formula Mass (S): 32.065 amu; Molar Mass (S): 32.065 g/mol

REACTIONS IN SOLUTIONS

- chemicals need to contact each other to react
  - can be hard to achieve for (not very soluble) solids
- reactions are often carried out in solution to facilitate contact between chemicals
  - In the liquid phase: MUCH MORE MOBILE
- chemicals must be dissolved to carry out reactions in solution

IMPORTANT CONCEPT: MOLARITY

- to measure the amount of particular reactant of a solution, we must know the solutions molarity
  - how many moles of substance are dissolved in 1L of solution
  - Unit symbol: M (always capital) ex: 3M HCl = 3 molar HCl
- when talking about solution, we need to know several other terms

SOLUTION: a homogenous, liquid mixture
SOLUTE: the substance dissolved in a solution
SOLVENT: the major component in a solution

HOW TO PREPARE SOLUTIONS

- we cannot just mix 1 mol of solute with 1L of solvent
  - volume of solution is likely not 1L then!

THE ADVANTAGE OF USING MOLARITY

- molariy converts between mole of solute and liters of solution

Molarity = Moles of solute / Volume of solution

Volume of solution (L) = Moles of solute / Molarity

Moles of solute = Molarity x volume of solution(L)

Ex: what is the molarity of a solution that has 1.2 moles of ammonia per 250 mL?

NH4OH = 1.2 moles / 0.25 L

ANS: 4.8M

IF THERE IS TOO CONCENTRATED OF A SOLUTION IN THE CHEM LAB, ONE MAY HAVE TO DILUTE THE SOLUTION