

Chemical Stoichiometry

Stoichiometry - The study of **quantities** of materials **consumed** and **produced** in chemical reactions.

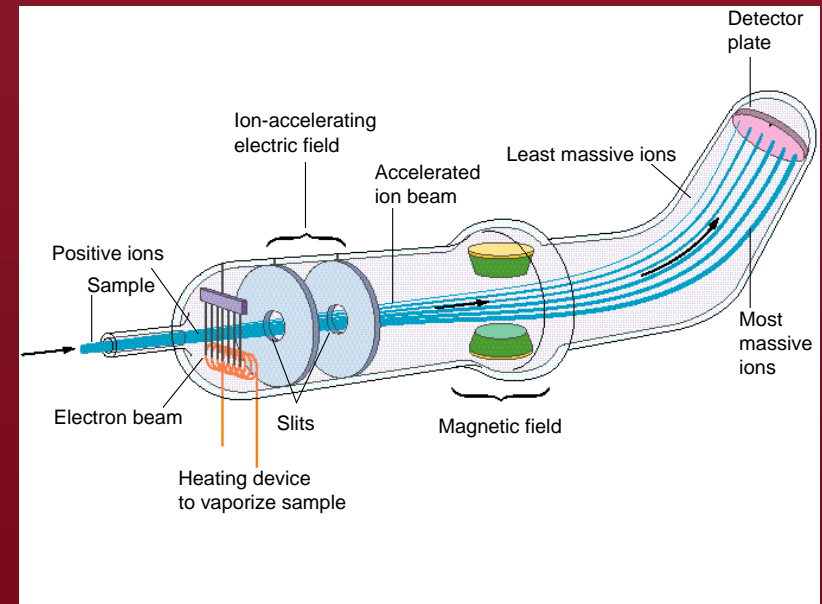
Atomic Masses

Elements occur in nature as mixtures of isotopes

Carbon = 98.89% ^{12}C
1.11% ^{13}C
<0.01% ^{14}C

Carbon atomic mass = 12.01

amu



Mass spectrometer

The Mole

The number equal to the **number** of carbon atoms in exactly 12 grams of pure ^{12}C .

1 mole of anything = **6.022×10^{23}** units of
that thing

Avogadro's number
equals
 6.022×10^{23} units

Molar Mass

A substance's **molar mass** (molecular weight) is the mass in grams of one mole of the compound.



Percent Composition

Mass percent of an element:

$$\text{mass \%} = \frac{\text{mass of element in compound}}{\text{mass of compound}} \times 100\%$$

For iron in iron (III) oxide, (Fe_2O_3)

$$\text{mass \% Fe} = \frac{111.69}{159.69} \times 100\% = 69.94\%$$

Formulas

molecular formula = (empirical formula)_{*n*}
[*n* = integer]

molecular formula = C₆H₆ = (CH)₆

empirical formula = CH

Empirical Formula Determination

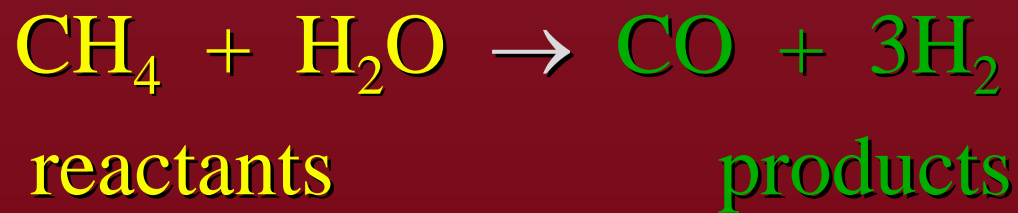
1. Base calculation on 100 grams of compound.
2. Determine moles of each element in 100 grams of compound.
3. Divide each value of moles by the smallest of the values.
4. Multiply each number by an integer to obtain all whole numbers.

Chemical Equations

Chemical change involves a reorganization of the atoms in one or more substances.

Chemical Equation

A representation of a chemical reaction:



Chemical Equation



The equation is balanced.

1 mole of methane reacts with 1 mole of water

to produce

1 mole of carbon oxide and 3 moles of hydrogen

Calculating Masses of Reactants and Products

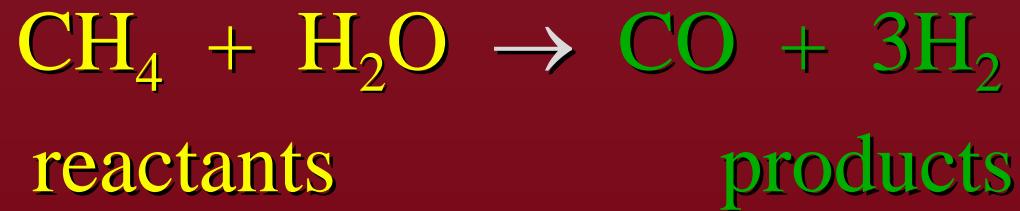
1. Balance the equation.
2. Convert mass to moles.
3. Set up mole ratios.
4. Use mole ratios to calculate moles of desired substituent.
5. Convert moles to grams, if necessary.

Limiting Reactant

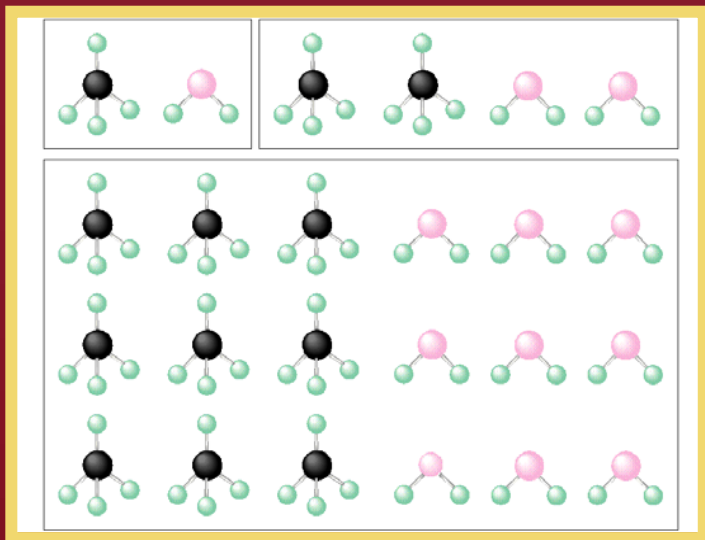
The **limiting reactant** is the reactant that is **consumed first**, limiting the amounts of products formed.

Limiting Reactant

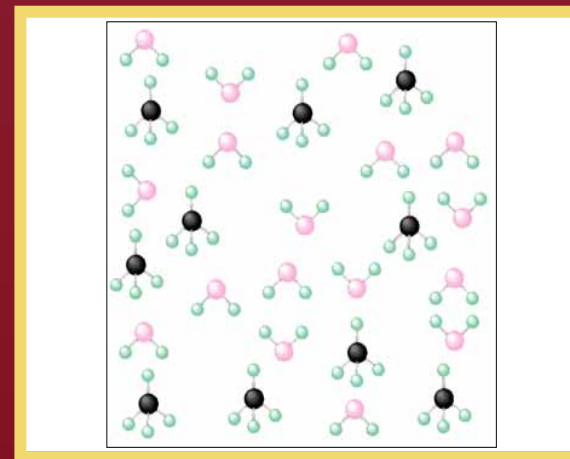
Let's start from the same reaction:



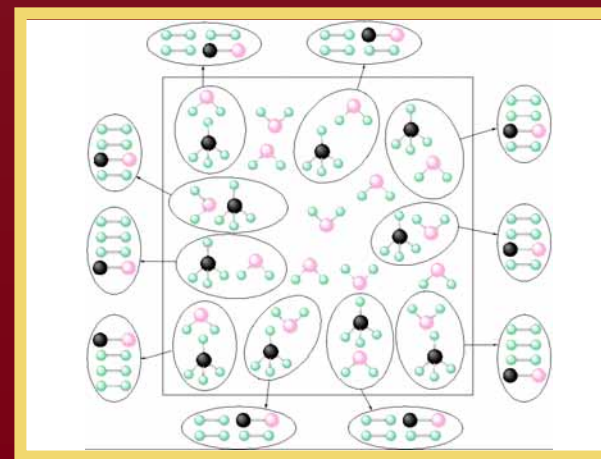
How does it work?



No problem, if they are mixed in stoichiometric ratio



But, if one reactant is in excess (H_2O) not all molecules react



Solving a Stoichiometry Problem

1. Balance the equation.
2. Convert masses to moles.
3. Determine which reactant is limiting.
4. Use moles of limiting reactant and mole ratios to find moles of desired product.
5. Convert from moles to grams.