Stoichiometry

CHM 1032c
Reactions part II

Quantifying Chemical Reactions

Microscopic world	Macroscopic world
amu	grams
atoms or molecules	moles
1 carbon atom = 12 amu	1 mole of carbon = 12 grams
1 water molecule = 18 amu	1 mole of water = 18 grams

The mole (6.02×10^{23})

- A macroscopic version of the molecule defined so we can use the periodic table for the macroscopic and microscopic world.
- Defined as the number of atoms in exactly 12.0 g of carbon-12 isotope.
- This is number is called Avogadro's Number after the Italian physicist Amedeo Avogadro (1776-1856).

How Big is a Mole

If you distribute equally $6x10^{23}$ dollars to every human being on the planet and spend a million dollars an hour it would would take more than 10,000 years to spend your share!

Traveling at the speed of light it would take more than a 100 billion years to travel $6x10^{23}$ miles!

A stack of $6x10^{23}$ pennies would be so tall that it would take 100,000 years traveling at the speed of light to go from one end of the stack to the other!

It would take more than a 100 trillion years to print $6x10^{23}$ dollars at a rate of 100 dollars per seconds!

Formula Weight

- The sum of the atomic weights of all the atoms in the molecular formula, whether ionic or molecular.
- Expressed in amu/molecule or grams/mole.
- Also called molecular weight, molar mass

Formula Weight

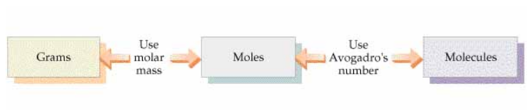
H_2O

$Ca(OH)_2$

$(NH_4)_3PO_4$

Two major conversion factors

- Avagadro's number inter-converts the microscopic and macroscopic worlds
- formula weight inter-converts grams and moles.



A silly problem

- How many molecules are in one drop (0.0500 g) of water?

Mole relationships in reactions

How many moles of H_2 are required to react with 2.8 moles of N_2according to the following equation?

$$3\ H_2 + N_2 \rightarrow 2\ NH_3$$

Weight relationships in reactions

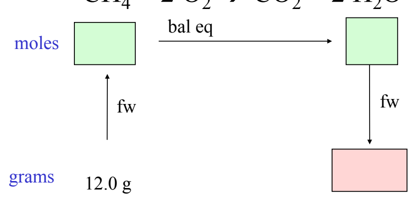
- Stoichiometry - Study of the mass relationship between reactants and product in chemical reactions.

Always start with a balanced chemical equation!

1. Convert grams of A to moles of A. (Use FW)
2. Convert moles of A to moles of B. (Use Eq.)
3. Convert moles of B to grams of B. (Use FW)

How many grams of H_2O are produced from the combustion of 12.0 grams of CH_4?

$$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$$



Other Stoichiometry concepts

- Limiting reagent
- percent yield
  - % yield = (actual yield/theoretical yield) x 100