Announcements

To join clicker to class today (Clickers with LCD display join automatically):

- Turn on the Clicker (the red LED comes on).
- Push "Join" button followed by "20" followed by the "Send" button (switches to flashing green LED if successful).

- Exam 2 next Monday.
- Do not enter room until told to.
- Bring ID

Review

- Calculating molar mass (ex. H_2O).
  - 1 mol contains 6.022×10^{23} things (called Avogadro's #, symbol N_A). Can also be thought of as amu/g.

(2 mol H/mol H_2O)(1.00794 g H/mol H) = 2.01588 g H/mol H_2O

+(1 mol O/mol H_2O)(15.9994 gO/mol O)=15.9995 g O/mol H_2O

18.0153 g H_2O/mol

- Balancing chemical equations.
- Using molar mass and balanced equations to calculate amounts used in a reaction. (Stoichiometry and the mole map)

mass of A -{÷MM(A)}-> moles of A -{mole ratio}-> moles B -{xMM(B)}-> mass B

% Composition: useful data for examples

- MM(H_2O)= 18.0153 g H_2O/mol H_2O.
- MM(CO_2) = 44.01 g CO_2 /mol CO_2

- Molecules called ethylene and propylene are both 14.372% by mass H. The rest is carbon (85.628%).
  - MM(ethylene)= 28.054 g/mol
  - MM(propylene)= 42.081 g/mol

Some extra practice problems to try at home

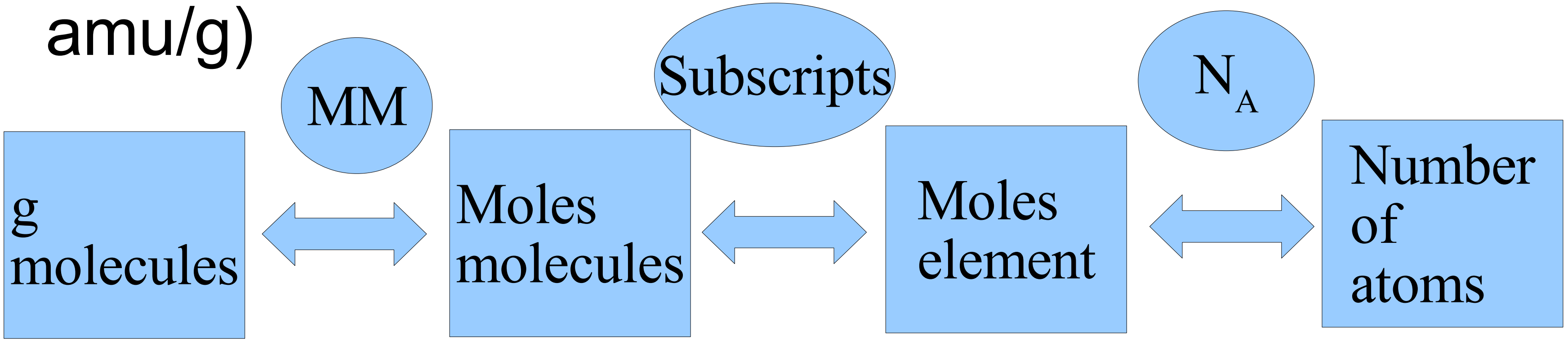
A) A compound containing only C and H was completely burned in oxygen to give water and carbon dioxide. It yielded 0.1802 g of H_2O and 0.3521 g of CO_2. What is the empirical formula for this compound?

B) If the molar mass of the compound in A is known to be about 58 g. What is the <u>molecular formula</u> of this compound?

Answers: A) C_2H_5 B) C_4H_{10}

Avogadro's Number and Molar Mass

- N_A=6.022 x 10^{23} particles/mole (also number of amu/g)



- Ex: suppose you have 24.022 g SO_3 how many O atoms? Info: 80.064 g SO_3/mol SO_3 or MM(SO_3)= 80.064 g/mol
  - atoms O = (24.022 g SO_3)(1mol SO_3/80.064 g SO_3) x (3O/SO_3)(6.022 x 10^{23} mol^{-1}) = 5.420 x 10^{23} O atoms

Steps to Balance Chemical Equations

1. Write correct molecular formula (empirical formula if ionic) for reactants and product (reactants on left, products on right).
2. Start with the heaviest atom other than O or H and balance those. Note: it is best to start with atoms that appear in only one compound on each side.
3. After doing all the other atoms balance O, then H.
4. HINT: ALWAYS CHECK THAT CHEMICAL EQUATIONS ARE BALANCED.
   - EXCEPTION: ON EXAMS IF YOU ARE TOLD THAT AN EQUATION IS BALANCED YOU MAY ASSUME IT IS.

Stoichiometry/Mole Map

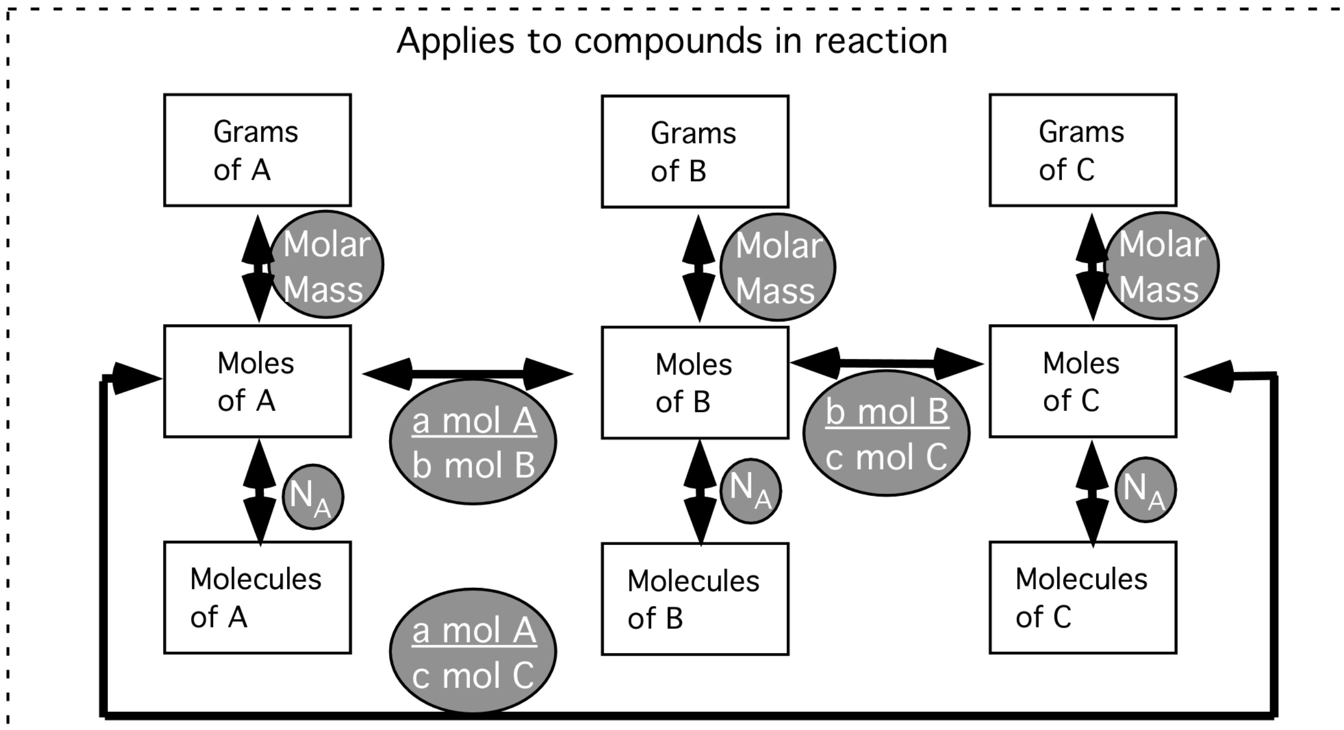
Model Reaction: $aA + bB \longrightarrow cC$

A, B and C represent molecular formulas

a, b and c represent the stoichiometric coefficients

(grey oval) = conversion factor

$N_A = 6.022 \times 10^{23} \frac{\text{things}}{\text{mole}}$



Stoichiometry

- Can answer questions like: How much SO_3 necessary to produce the 3.959×10^{10} kg of H_2SO_4 manufactured in 2000?
- Produced using same RXN as occurred in early atmosphere: SO_3(g) + H_2O(l) ---> H_2SO_4(aq) (balanced).
- Key info
  - 80.064 g SO_3/mol SO_3 or $\mathcal{M}(SO_3)$= 80.064 g/mol
  - 98.079 g H_2SO_4/mol H_2SO_4 or $\mathcal{M}$ (H_2SO_4)= 98.079 g/mol
- Route to solution (know amount of A want amount of B):

  mass of A -{÷$\mathcal{M}$(A)}-> moles of A -{mole ratio}-> moles B -{x$\mathcal{M}$(B)}-> mass B

Review

- History of atomic models:
- e^- embedded in positive sphere (~1900)
- Rutherford Exp (1910) = dense nucleus (+) and e^- somewhere outside
- Photoelectric effect, emission and absorption line spectra suggested that e- are trapped in quantized energy levels.
- Practiced calculating ΔE of a transition between quantum states.

Review

- Bohr Atom
  - $E_n = -R_H/n^2$ ($R_H = 2.179 \times 10^{-18}$ J/atom)
  - Use E_n to calculate $\Delta E = E_f - E_i$ for transitions
  - had problems solved by wave-particle duality
    - modelled by deBroglie eq. $\lambda = h/mv$
    - electrons are standing waves around nucleus
- Full quantum mechanics gives wave functions (ψ)
  - orbitals show probable location of electrons (ψ^2)
  - shapes of s=sphere,p=dumb bell,d and f =complex
  - nodes are places where there is no probability of finding an electron which is in that orbital.

Review

- How to read the ground state electronic configuration from the periodic table.
  - Extra stability of half-full and full d leads to moving electron from s to d. Cr: $[Ar]3d^5 4s^1$ and Cu:$[Ar]3d^{10} 4s^1$.
  - f-Block filling order varies.
- Higher numbered shells (n-levels) are higher energy because they are farther from the nucleus on average.

Review

- Shielding leads to different energies of s, p, d, etc. orbitals within a single shell.
- Specifing excited states and ground states.
- Periodic trends in first ionization energy, radius, ion formation and ionic radius.
- Vocabulary: metal, metalloid (semiconductor or semimetal), nonmetals, alkali metals, alkali earth metals, halogens, noble gases.
- Earth composed of mostly heavier elements, with denser substances more towards center.
- Least dense substances formed early atmosphere.

Review

- Naming binary compounds, oxoacids, halogen acids, and hydrates of ionic compounds.
  - CO: carbon monoxide – SO_3: sulfur trioxide
  - $CaCl_2$: calcium chloride – Mn_2O_3: manganese (III) oxide
  - Na_2HPO_4: sodium hydrogen phosphate
  - H_3PO_4: phosphoric acid – HF: hydrofluoric acid
  - $CuSO_4 \cdot 2H_2O$: copper (II) sulfate dihydrate
- Calculating molar mass
- Balancing chemical equations.
- Using molar mass and balanced equations to calculate amounts used in a reaction. (Stoichiometry and the mole map)

  mass of A -{÷MM(A)}-> moles of A -{mole ratio}-> moles B -{xMM(B)}-> mass B
- Empirical and molecular formulas from % composition and combustion analysis.