Class #2
Molecules and Moles

CHEM 107
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Molecules & Moles

• Number of molecules in any macroscopic sample is huge
• Use \textit{moles} as a unit of quantity
• 1 mole $= 6.022140857 \times 10^{23}$
• This is an experimentally measured number ("Avogadro’s Number")
Avogadro’s Number

- Defined by setting
  1 mole $^{12}\text{C} = 12 \text{ g}$ (exactly)
- Definition of the amu is
  1 atom $^{12}\text{C} = 12 \text{ amu}$ (exactly)
- Mass of a single atom or molecule in amu is numerically equal to mass of one mole in grams

Mass, moles, # of molecules

- Converting between these is just changing units.
- Use atomic & molecular weights, densities, etc. as needed.
Simple Mole Calculation

• A 12-inch cast iron skillet weighs about 8.4 pounds.
• How many moles of iron is that?
• How many iron atoms?

Molar mass of molecules

• Conservation of mass means that: Molar mass of a molecule is the sum of the molar masses of the atoms in the molecule.
• Water: $\text{H}_2\text{O} \rightarrow 2 \text{ H's} + 1 \text{ O}$

$$2(1.0079 \text{ g/mol}) + 1(15.9994 \text{ g/mol}) = 18.0152 \text{ g/mol}$$
Example from last time

- Formula is $C_{15}H_{20}N_2O_2$
- Molar mass?

Formulas & % composition

- Given a chemical formula, it's easy to find mass %'s
- Find molar mass and the mass from each element
- As an example, calculate mass % of each element in the previous molecule

69% C, 7.7% H, 11% N, 12% O
Composition & formulas

- Reverse process is useful in analyzing unknowns
- Instruments can tell us the elemental composition of a substance ("elemental analysis")
- We can convert this info into a molecular formula

Composition & formulas: Example

- Nicotine contains 74.0% C, 8.65% H, and 17.35% N. If the molar mass of nicotine is 162, what is the chemical formula of nicotine?
- Approximate atomic weights for C, H, and N are 12, 1, and 14.
% Composition & Formula

• Nicotine contains 74.0% C, 8.65% H, and 17.35% N. (If the molar mass of nicotine is 162), What is the chemical formula of nicotine?
• Atomic weights for C, H, and N are 12, 1, and 14.

Empirical vs. Molecular formulas

• Nicotine shows the difference between these ideas
• Empirical formula: simplest possible formula with correct ratios of atoms
• Molecular formula: formula showing actual composition of a molecule