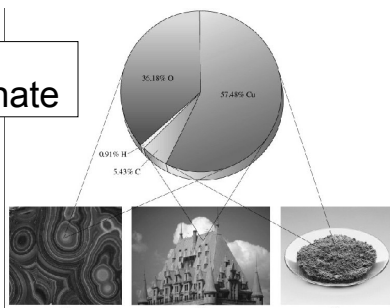


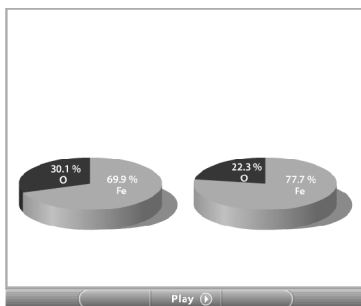
Stoichiometry

Percent Composition and Empirical Formulas

Chemical compounds have the same mass ratio of elements no matter how formed

Copper Bicarbonate





New Material

Percentage Composition

- The **percentage composition** of a compound is the percentage by mass contributed by each element in the substance:

$$\% \text{composition} = \frac{(\# \text{ of atoms of element})(\text{A W of element})}{\text{FW of compound}} \times 100\%$$

- AW means Atomic Weight
- FW means Formula Weight
- Subscript

Percent composition (by mass) of NaN_3

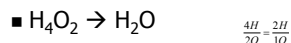
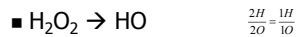
$$\% \text{ Na} = \frac{\text{g/mol Na}}{\text{g/mol NaN}_3} \times 100\% = \frac{23.0 \text{ g/mol}}{65.0 \text{ g/mol}} \times 100\% = 35.4\%$$

$$\% \text{ N} = \frac{3(\text{g/mol N})}{\text{g/mol NaN}_3} \times 100\% = \frac{3(14.0 \text{ g/mol})}{65.0 \text{ g/mol}} \times 100\% = 64.6\%$$

$$\text{Or } 100 - 35.4 = 64.6\%$$

Empirical Formula

- The **empirical formula** of a compound tells the relative number of atoms of each element it contains



Empirical Formula

- The empirical formula also represents molar quantities:
 - In 1 mol of H_2O_2 there are 2 mol H for every 2 mol O (1:1)
 - In 1 mol of H_2O there are 2 mol H for every 1 mol O (2:1)
- Empirical formulas are found through experiment:
 - A compound is broken down into its basic components.
 - The mass of each component is determined.
 - The relative numbers of moles of each are calculated.

Example of Empirical Formula

- 100g of compound is determined to contain 73.9g Hg (73.9%) and 26.1g Cl (26.1%).
- To determine the empirical formula of the compound, we need to find the relative numbers of mol of each component.
 - The number of moles of Hg recovered is:

$$73.9g \text{ Hg} \frac{1 \text{ mol Hg}}{200.6g \text{ Hg}} = 0.368 \text{ mol Hg}$$

- The number of moles of Cl recovered is:

$$26.1g \text{ Cl} \frac{1 \text{ mol Cl}}{35.45g \text{ Cl}} = 0.735 \text{ mol Cl}$$

Empirical Formula

- To find the ratio we divide the larger number of moles by the smaller:

$$\frac{0.735 \text{ mol Cl}}{0.368 \text{ mol Hg}} = 1.99 \approx 2$$

- The empirical formula of the compound is: **HgCl₂**

Empirical Formula

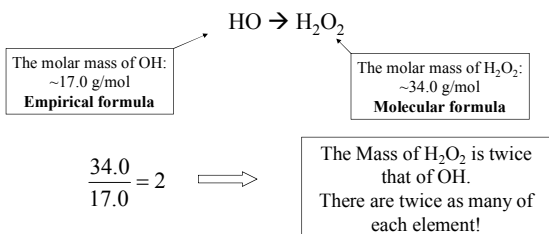
■ In general, we can follow three basic steps
_____ to calculate empirical formulas:

1. Change % to grams (i.e. you can assume a 100g sample) and calculate the number of moles using molar masses on periodic table
2. Find the ratio of moles of each component to the smallest number of moles
3. Write the empirical formula

Molecular Formulas

■ In the previous examples we calculated empirical formulas. The SMALLEST WHOLE NUMBER RATIO.

■ **The actual molecular formula may be different:**



Molecular Formula

- The headache remedy, Ibuprofen, contains
- 75.69% C, 8.80 % H, and 15.51% O by mass.
- The molar mass of ibuprofen is 206g/mol.
- Calculate the empirical and molecular formula for this compound:
- **HOW DO WE DO THAT?**

Steps to write Molecular Formula

- First Write Empirical Formula
 - Assume a 100g sample and change % to grams
 - Calculate the number of moles using molar masses on your periodic table and find the ratio of moles of each component to the smallest number of moles
 - Write Empirical Formula

Calculation continued

- Finally,
 - calculate the molecular formula using the molar mass
