Chemical Formulas

Empirical Formula - Shows the *relative* number of atoms of each element in the compound. It is the simplest formula, and is derived from masses of the elements.

Molecular Formula - Shows the *actual* number of atoms of each element in the molecule of the compound.

Structural Formula - Shows the actual number of atoms, and *the bonds between them* ; that is, the arrangement of atoms in the molecule.

Empirical and Molecular Formulas

Empirical Formula - The simplest formula for a compound that agrees with the elemental analysis! The smallest set of whole numbers of atoms.

Molecular Formula - The formula of the compound as it exists, it may be a multiple of the Empirical formula.

Calculating the Moles and Number of Formula Units in a Given Mass of Cpd.

Problem: Sodium Phosphate is a component of some detergents. How many moles and formula units are in a 38.6 g sample?

Plan: We need to determine the formula, and the molecular mass from the atomic masses of each element multiplied by the coefficients.

Solution: The formula is Na_3PO_4. Calculating the molar mass:

M = 3x Sodium + 1 x Phosphorous = 4 x Oxygen =

= 3 x 22.99 g/mol + 1 x 30.97 g/mol + 4 x 16.00 g/mol

= 68.97 g/mol + 30.97 g/mol + 64.00 g/mol = 163.94 g/mol

Converting mass to moles:

$$\text{Moles } Na_3PO_4 = 38.6 \text{ g } Na_3PO_4 \times \frac{1 \text{ mol } Na_3PO_4}{163.94 \text{ g } Na_3PO_4}$$

$$= \mathbf{0.235 \text{ mol } Na_3PO_4}$$

$$\text{Formula units} = 0.235 \text{ mol } Na_3PO_4 \times \frac{6.022 \times 10^{23} \text{ formula units}}{1 \text{ mol } Na_3PO_4}$$

$$= \mathbf{1.42 \times 10^{23} \text{ formula units}}$$