Types of Chemical Formulas

Empirical (Simpliest) Formula-

Formula whose subscripts represent the simplest whole number ratio of atoms in a molecule or the simplest whole number ratio of moles of each element in a mole of the compound. The simplest formula is usually determined by considering experimental data hence the name "empirical" which means based on experimentation. It speaks of relative numbers. For example, CH_2 says that there will be twice as many Hydrogens as there are carbons in the compound that has this simplest formula. It does not address how many exact numbers of Hydrogens and Carbons there will be in the compound.

Molecular Formula-

A formula whose subscripts represent the absolute exact numbers of atoms of each element per molecule of the compound or the absolute number of moles of each element per mole of the compound. A molecular formula may be reducible to a simple formula if all its subscripts are divisible by a common denominator.

Some compounds have the same empirical and molecular formula. For example, Carbon Dioxide has as its empirical and molecular formula CO_2. The empirical and molecular formula for Sulfur Dioxide are the same SO_2.

There are many situations where two or more compounds have the same simplest formula, but differ by their molecular formulas. For example, Benzene and acetylene have the same simplest formula, CH. However, Benzene's molecular formula is C_6H_6 and acetylene's molecular formula is C_2H_2.

Structural Formula-

Formula that not only gives via its subscripts the exact number of atoms of each element per molecule but it displays the way that the atoms are bonded together and the shape of the molecule is revealed. There are compounds that have the same empirical formula and even the same molecular fmula and the only way that they can be distinguished is through their structural Formulas. For example, two unique compounds, Cis dibromoethene and Trans dibromoethene have the same simplest formula CHBr, and the same molecular formula $C_2H_2Br_2$. The only way that they can be distinguished is through their structural formulas:

Trans dibromoethene has the Bromines on opposite sides of the double bond

Cis dibromoethene has thr Bromines on the same side of the double bond

Interpretation of Formulas

Some typical chemical formulas are:

H_2O for water

NaCl for table salt

C_2H_6O for Ethyl alcohol

$C_{12}H_{22}O_{11}$ for table sugar

The numbers between the letters are subscripts and represent the number of atoms of the element that they follow in one molecule of the substance. So for example:

H_2O has two atoms of Hydrogen and 1 atom of Oxygen for every molecule of water. This can also be interpreted as 2 moles of Hydrogen and 1 mole Oxygen in one mole of H_2O. The mole interpretation is the more practical interpretation because we are not capable of seeing single molecules and atoms for everyday work.

C_2H_6O has two atoms of Carbon, 6 atoms of Hydrogen, and 1 atom of Oxygen in every molecule of Ethyl Alcohol. The preferable mole interpretation would be two moles of Carbon, six moles of Hydrogen, and one mole of Oxygen in one mole of Ethyl Alcohol.

$C_{12}H_{22}O_{11}$ has 12 atoms of Carbon, 22 atoms of Hydrogen, and 11 atoms of Oxygen in one molecule of Table sugar. The mole interpretation would be 12 moles of Carbon, 22 moles of Hydrogen, and 11 moles of Oxygen in every mole of Table sugar.