

## Composition of Compounds Resource Paper 1

# Solving Empirical & Molecular Formula Problems

It was observed experimentally that the proportions of specific elements in a compound did not vary even if the size of the sample being analyzed increased or decreased. Therefore, for example, one could describe a new material as being 60% carbon and 40% hydrogen by mass. Using the periodic table, mass percents can be converted to mole percents, and these values can be used to determine the ratio of the various elements to one another within the compound. This information could then be used to write an **empirical formula** for the compounds, which is essentially a “lowest common multiple” of the compound’s true formula, or **molecular formula**. Given only the percent information and the molecular weight of the compound, one can easily determine these formulas.

The procedure for this process is simple:

### To determine the empirical formula:

1. Assume a 100 g sample of the compound.
2. “Convert” the percents of each element to masses.
3. Convert the masses to mole quantities using the molar weights of each element.
4. Simplify the mole ratio by dividing each mole quantity by the lowest value obtained in step 3.
5. If any fractional mole values result from step 4, multiply all of the values by the reciprocal of the *fractional portion* of the value (for example, if one of the values was 3.5, all of the values would be multiplied by 2, which is the reciprocal of the fractional portion of 3.5 – the value of 0.5 [1/2]).
6. Write the empirical formula, using the resultant values as the subscripts for the elements in the compounds.

### To determine the molecular formula:

1. Determine the empirical mass of the compound; that is, the molar mass of the empirical formula.
2. Divide the molecular mass by the empirical mass.
3. Multiply all of the subscripts in the empirical formula by the resulting factor.

### Example Problem:

What is the molecular formula for a material that is 92.2% C and 7.80% H by mass? The material has a molar mass of 52.0 g/mol.

