Math Diversion Problem 925

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Thanksgiving isn't thanksgiving until
you've said thanks.
— Pastor Price

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Source: Chemical Principles: Quest for Insight, 3rd Ed
Title: Problem  4. p. F49 F.9
  Presenter: Atkins and Jones
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1 Problem

L-Dopa, a drug used for the treatment of Parkinson's disease, is 54.46 % C, 5.62 % H, 7.10 % N, and 32.46 % O. What is the empirical formula of the compound?

2 Solution

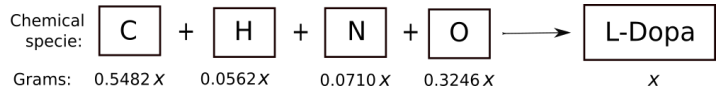

Figure 1. We imagine starting with an unknown amount of grams of L-Dopa, which we represent by the unknown x. Next, we convert the percentage of each element by weight into decimal amounts by weight, that is, in grams.

Now, all we care about is the combined ratios of these elements by weight, so we can divide through by x to get the corresponding ratios:[1]

$$.5482, \quad .0562, \quad 0.0710, \quad 0.3246\,. \tag{*}$$

Next, we divide each element by its respective grams/mole to get the combined mole ratios:

$$0.04568, \quad 0.0557, \quad 0.005069, \quad 0.02029\,.$$

[1] When taking ratios, one can always divide out a common factor.

Next, we divide through by the smallest number in this list and round off the results to their nearest integer: 9, 11, 1, 4

We're actually finished because the GCD of all these numbers is 1, therefore, there is no other common factor greater than one that can be divided out.

Thus, the empirical formula of L-Dopa is $C_9H_{11}NO_4$

But wait!! Why go to all this effort to write down a figure (Fig. 2) just to extract from it the obvious data one needs to solve this problem, which is the data on line (*)?

Well, I can't tell the reader when it should be written down, but the reader should be able to write it down as proof that he or she understands how to justify the data on line (*), and to understand what it means. From the beginning, this series of stoichiometry papers has been designed to teach stoichiometry problems as algebra word problems. What Fig. 2 demonstrates is that even in chemical processes, a total is equal to the sum of its parts, and that is how one justifies line (*).