

Empirical Formula

The empirical formula of a compound shows the basic ratio of elements within that compound. For example, consider the hydrocarbon alkane, ethane, which has a molecular formula of C_2H_6 . Its empirical formula would be CH_3 , because the ratio of Carbon to Hydrogen atoms in the molecule is 1 : 3.

For some compounds like H_2O , the empirical and molecular formula are the same

Empirical formulae are determined experimentally by finding the mass of each element within the compound.

Consider the following example

A sample of an unknown hydrocarbon of mass 1.452 g was burnt completely in oxygen forming 4.401 g of CO_2 and 2.252 g of H_2O . What was its empirical formula.

we have an equation of the following form

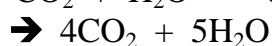
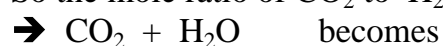


if we can work out the mole ratio of CO_2 and H_2O , then we can work out the molecular formula of the hydrocarbon

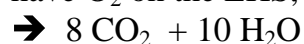
$$n(CO_2) = \frac{4.401}{44} = 0.10 \text{ mol}$$

$$n(H_2O) = \frac{2.252}{18} = 0.125 \text{ mol}$$

So the mole ratio of CO_2 to H_2O , is .01 : .125 or 4 : 5



however, this leaves us with an odd number of O on the RHS and since we have O_2 on the LHS, we need to double the numbers on the RHS



Some simple arithmetic gives us an equation



Hence the empirical formula is C_2H_5

The molecular formula can be verified as follows

mole ratio of C_8H_{20} to CO_2 is 1 : 8

we calculated $n(CO_2) = 0.10 \text{ mol}$ above

so

$$n(C_8H_{20}) = \frac{0.10}{8} = 0.0125 \text{ mol}$$

We are told that there was 1.452 g of the hydrocarbon, so we can calculate its Molar Mass

$$n(\text{C}_8\text{H}_{20}) = \frac{\text{mass}}{\text{Molar_Mass}}$$

$$0.0125 = \frac{1.452}{MM}$$

$$MM = \frac{1.452}{0.0125}$$

$$MM = 116$$

this is in fact the MW of C_8H_{20}

This document was created with Win2PDF available at <http://www.daneprairie.com>.
The unregistered version of Win2PDF is for evaluation or non-commercial use only.