

extension

CROSS-DISCIPLINARY

Go to go.hrw.com for a full-length article on the importance of molecular shape in odors.



Keyword: HC6FRMX

Calculation of Molecular Formulas

Remember that the *empirical formula* contains the smallest possible whole numbers that describe the atomic ratio. The *molecular formula* is the actual formula of a molecular compound. An empirical formula may or may not be a correct molecular formula. For example, diborane's empirical formula is BH_3 . Any multiple of BH_3 , such as B_2H_6 , B_3H_9 , B_4H_{12} , and so on, represents the same ratio of B atoms to H atoms. The molecular compounds ethene, C_2H_4 , and cyclopropane, C_3H_6 , also share an identical atomic ratio (2 H:1 C), yet they are very different substances. How is the correct formula of a molecular compound found from an empirical formula?

The relationship between a compound's empirical formula and its molecular formula can be written as follows.

$$x(\text{empirical formula}) = \text{molecular formula}$$

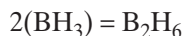
The number represented by x is a whole-number multiple indicating the factor by which the subscripts in the empirical formula must be multiplied to obtain the molecular formula. (The value of x is sometimes 1.) The formula masses have a similar relationship.

$$x(\text{empirical formula mass}) = \text{molecular formula mass}$$

To determine the molecular formula of a compound, you must know the compound's formula mass. For example, experimentation shows the formula mass of diborane to be 27.67 amu. The formula mass for the empirical formula, BH_3 , is 13.84 amu. Dividing the experimental formula mass by the empirical formula mass gives the value of x for diborane.

$$x = \frac{27.67 \text{ amu}}{13.84 \text{ amu}} = 2.000$$

The molecular formula of diborane is therefore B_2H_6 .



Recall that a compound's molecular formula mass is numerically equal to its molar mass, so a compound's molecular formula can also be found given the compound's empirical formula and its molar mass.

SAMPLE PROBLEM N

For more help, go to the *Math Tutor* at the end of Chapter 22.

In Sample Problem M, the empirical formula of a compound of phosphorus and oxygen was found to be P_2O_5 . Experimentation shows that the molar mass of this compound is 283.89 g/mol. What is the compound's molecular formula?

SOLUTION

1 ANALYZE

Given: empirical formula

Unknown: molecular formula