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

Analysis of a 10.150 g sample of a compound known to contain only phosphorus and oxygen indicates a phosphorus content of 4.433 g. What is the empirical formula of this compound?

SOLUTION

1 ANALYZE   **Given:** sample mass = 10.150 g
phosphorus mass = 4.433 g
Unknown: empirical formula

2 PLAN   Mass composition $\longrightarrow$ composition in moles $\longrightarrow$ smallest whole-number ratio of atoms

3 COMPUTE   The mass of oxygen is found by subtracting the phosphorus mass from the sample mass.

$$\text{sample mass} - \text{phosphorus mass} = 10.150 \text{ g} - 4.433 \text{ g} = 5.717 \text{ g}$$

Mass composition: 4.433 g P, 5.717 g O

Composition in moles:

$$4.433 \text{ g P} \times \frac{1 \text{ mol P}}{30.97 \text{ g P}} = 0.1431 \text{ mol P}$$

$$5.717 \text{ g O} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = 0.3573 \text{ mol O}$$

Smallest whole-number mole ratio of atoms:

$$\frac{0.1431 \text{ mol P}}{0.1431} : \frac{0.3573 \text{ mol O}}{0.1431}$$

$$1 \text{ mol P} : 2.497 \text{ mol O}$$

The number of O atoms is not close to a whole number. But if we multiply each number in the ratio by 2, then the number of O atoms becomes 4.994 mol, which is close to 5 mol. The simplest whole-number mole ratio of P atoms to O atoms is 2:5. The compound's empirical formula is P_2O_5.

4 EVALUATE   The arithmetic is correct, significant figures have been used correctly, and units cancel as desired. The formula is reasonable because +5 is a common oxidation state of phosphorus.

PRACTICE   *Answers in Appendix E*

1. A compound is found to contain 63.52% iron and 36.48% sulfur. Find its empirical formula.

2. Find the empirical formula of a compound found to contain 26.56% potassium, 35.41% chromium, and the remainder oxygen.

3. Analysis of 20.0 g of a compound containing only calcium and bromine indicates that 4.00 g of calcium are present. What is the empirical formula of the compound formed?

extension
Go to **go.hrw.com** for more practice problems that ask you to determine empirical formulas.

Keyword: HC6FRMX