

Exercise 7.4a

Determining Formulas

Name: _____

Date: _____ Per: _____

Empirical formulas can be derived using the percent composition and the molar masses of the elements:

1. Assume that there is 100g of the sample present.
2. Assign mass values to each element based on its percentage.
3. Calculate the number of moles present by dividing the mass value by the molar mass of the substance.
4. Divide the each number of moles calculated by the smallest number of moles calculated, to arrive at a ratio.

Example: Find the empirical formula of a substance that is: 30.5% nitrogen and 69.5 % oxygen.

1. Assuming 100 g, there would be 30.5 g nitrogen and 69.5 g oxygen.
2. Calculate the number of moles present by dividing the mass value by the molar mass of the substance.
3. Divide the each number of moles calculated by the smallest number of moles calculated, to arrive at a ratio.

$$\frac{30.5 \text{ g N}}{14.007 \text{ g N}} = 2.18 \text{ mol N}$$

$$\frac{69.5 \text{ g O}}{15.999 \text{ g O}} = 4.34 \text{ mol O}$$

4. Divide the each number of moles calculated by the smallest number of moles calculated, to arrive at a ratio.

$$\text{N} \frac{2.18 \text{ mol N}}{2.18 \text{ mol N}} = 1 \text{ mol N/mol N}$$

$$\text{O} \frac{4.34 \text{ mol O}}{2.18 \text{ mol N}} = 2 \text{ mol O / mol N}$$



DIRECTIONS: Calculate the formulas of the compounds below based on the information given.

1. A compound is 52.7% potassium, 47.3% chlorine. What is the empirical formula?
2. A compound is 74.9% carbon, 25.1% hydrogen. What is the empirical formula?
3. A compound is known to contain the elements sodium, sulfur and oxygen. If it 36.5% sodium and 25.4% sulfur, what is its empirical formula?
4. Find the empirical formula of a compound that is 53.7% iron and 46.3% sulfur.
5. Analysis of a sample of a compound indicates that it has 1.04 g K, 0.700 g Cr, and 0.860 g O. What is its empirical formula?

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6. A solvent is found to be 37.5% carbon, 12.5% hydrogen, and 50.0% oxygen. What is the empirical formula of this solvent?
7. A compound is 25.3% copper, 12.9% sulfur, 25.7% oxygen, 36.1% water. What is the empirical formula?

Empirical formulas represent the simplest ratio of atoms that occur in a compound. That ratio may not, however, be the true formula of the compound because some formulas occur in ratios that can be reduced. For example, the formula of hydrogen peroxide is H_2O_2 , but its empirical formula would be HO . The formula of glucose is $\text{C}_6\text{H}_{12}\text{O}_6$, but its empirical formula would be CH_2O . The true formula of the substance is called the **molecular formula** because it represents the actual formula of the molecule. The molecular formula may be found by comparing the molar mass of the actual compound (which will be given) to the molar mass of the empirical formula.

Example: The empirical formula of a compound is CH . Its molecular mass is 78.1 g/mol. What is its molecular formula?

1. Molar mass of $\text{CH} = (12.011 \text{ g} + 1.008 \text{ g}) = 13.019 \text{ g}$.
2. Compare the real (molar) mass to the mass of the empirical formula: $78.1 \text{ g} \div 13.019 \text{ g} = 6$.
3. The real formula weighs 6 x the mass of CH , so the subscripts all get multiplied by 6 : **C_6H_6** .

8. The empirical formula of a compound is NO_2 . Its molar mass is 92.0 g/mol. What is its molecular formula?
9. Ethene, a gas used extensively in preparing plastics and other polymers, has a composition of 85.7% carbon and 14.3% hydrogen. Its molar mass is 28.1 g. Find the molecular formula for ethene.
10. A compound is found to be 40.0% carbon, 6.71% hydrogen and 53.5% oxygen. Its molar mass is 60.1 g/mol. What is its molecular formula?
11. If 4.04 g of nitrogen combine with 11.46 g of oxygen to produce a compound with a molar mass of 108.0g, what is the molecular formula of this compound?