

Chapter 8 - Empirical & Molecular Formula
 Dr. Gergens - SD Mesa College

1. Explain the difference between the empirical formula and the molecular formula of a compound.

An empirical formula is the smallest whole number ratio for a molecular formula.

2. The molecular formula of the gas acetylene is C_2H_2 .

What is the empirical formula?

C_2H_2 is divisible by “n ratio factor” of two;
 thus C_1H_1 is the empirical formula.

3. The empirical formula for a compound used in the past as green paint pigment is $C_2H_3As_3Cu_2O_8$.

The molar mass is 1013.71 grams. What is the molecular formula?

first, calculate the “n ratio factor”

$$\text{“n ratio factor”} = \frac{\text{molar mass}}{\text{empirical mass}}$$

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$$\text{“n ratio factor”} = \frac{\text{molar mass}}{\text{empirical mass}}$$

then divide molar mass by empirical mass

$$2C \times 12.0 = 24.0$$

$$3H \times 1.0 = 3.0$$

$$3As \times 74.9 = 224.7$$

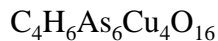
$$2Cu \times 62.9 = 125.6$$

molecular formula exists as two

$$\frac{80 \times 16.0 = 128.0}{\text{empirical mass} = 505.3 \text{ g/mol}}$$

$$[C_2H_3As_3Cu_2O_8] \times 2$$

empirical formula



molecular formula 1013.71 g/mol

The goal is to determine the mole amounts of each substance in the sample by converting all grams masses to moles

analysis	C = 39.99 %	H = 6.713 %	O = 53.29 %
grams assume 100 g sample	39.99 grams	6.713 grams	53.29 grams
MM (molar mass)	12.0 g/mol	1.0 g/mol	16.0 g/mol
mole	3.33 mol	6.71 mol	3.33 mol
ratio	3.33 mol	6.71 mol	3.33 mol
divide by the smallest	3.33 mol	3.33 mol	3.33 mol
whole number ratio	C ₁	H ₂	O ₁

This type of analysis always produces the lowest whole number ratio, thus we have now just calculated the empirical formula

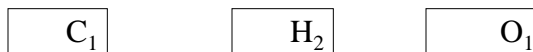
To check your work, consider calculating a percentage composition

The empirical formula for the sugar used in the analysis is C₁H₂O₁. Calculate a percentage composition of each element in the formula.

1. calculate the empirical mass

$$\begin{array}{l}
 1\text{C} \times 12.0 = \frac{12.0 \text{ parts}}{30.0} = 0.400 \times 100 \% = 40.0 \% \\
 2\text{H} \times 1.0 = \frac{2.0}{30.0} = 0.67 \times 100 \% = 6.7 \% \\
 1\text{O} \times 16.0 = \frac{16.0}{30.0} = 0.400 \times 100 \% = 53.3 \% \\
 \hline
 \text{empirical mass } 30.0 \text{ g/mol} \\
 \text{whole}
 \end{array}$$

2. Divide the parts by the whole and times by 100 %



This type of analysis always produces the lowest whole number ratio, thus we have now just calculated the empirical formula

5. Using the empirical formula and molar mass that was given determine the molecular formula for the substance given the molar mass is 210.18 g/mol

The empirical formula for a compound used in the past as $C_1H_2O_1$

The molar mass is 210.18 g/mol . What is the molecular formula?

first, calculate the "n ratio factor"

$$\text{"n ratio factor"} = \frac{\text{molar mass}}{\text{empirical mass}}$$

~~for each individual element by its atomic mass~~

$$1C \times 12.0 = 12.0$$

$$2H \times 1.0 = 2.0$$

$$1O \times 16.0 = 16.0$$

~~empirical mass 30.0 g/mol~~

~~molecular formula exists as two~~

~~empirical formulas~~

$$[C_1H_2O_1] \times 6$$

empirical formula

$$\text{"n ratio factor"} = 6$$

~~$C_6H_{12}O_6$~~

~~molecular formula 210.18 g/mol~~