

Molecular vs. Empirical Formula Chemistry

Name _____

Block _____

Read the information below and then answer the questions that follow

Definitions:

- **Molecular formula** – the *total number* of atoms of each element in a compound
- **Empirical formula** – the *simplest/smallest ratio* of each element in a compound

Examples:

Substance	Molecular Formula	Simplifying the Ratio	Empirical Formula
Sugar	C ₆ H ₁₂ O ₆	$\frac{C_6}{6} \frac{H_{12}}{6} \frac{O_6}{6}$	CH ₂ O
Water	H ₂ O	$\frac{H_2}{1} \frac{O_1}{1}$	H ₂ O
Hydrogen Peroxide	H ₂ O ₂	$\frac{H_2}{2} \frac{O_2}{2}$	HO
Salt (Sodium Chloride)	NaCl	$\frac{Na_1}{1} \frac{Cl_1}{1}$	NaCl
Ribose	C ₅ H ₁₀ O ₅	$\frac{C_5}{5} \frac{H_{10}}{5} \frac{O_5}{5}$	CH ₂ O

Molecular & Empirical Formulas Part 1

Calculate the Molar Masses and % composition for both the empirical and molecular formula below. Then, determine a similarity and difference between the two.

Substance	Molecular Formula (MF)	Empirical Formula (EF)
Sugar	C ₆ H ₁₂ O ₆	CH ₂ O
Molar Mass		
%Composition	% C: % H: % O:	% C: % H: % O:

Similarity between MF & EF	Difference between MF & EF

Molecular & Empirical Formulas Part 2

Substance	Molecular Formula	Empirical Formula
Water	H ₂ O	H ₂ O
Salt (Sodium Chloride)	NaCl	NaCl

You should have noticed that for both substances, the Molecular & Empirical Formulas are the same. *Explain why it is possible for both the Molecular & Empirical Formulas to be the same.*

Molecular & Empirical Formulas Part 3

Substance	Molecular Formula	Empirical Formula
Glucose	C ₆ H ₁₂ O ₆	CH ₂ O
Ribose	C ₅ H ₁₀ O ₅	CH ₂ O

You should have noticed that both substances have the same empirical formula. *Explain why it is possible for two different MFs and have the same EF.*

Molecular & Empirical Formulas Part 4

Substance	Molecular Formula (MF)	Empirical Formula (EF)
Hydrogen Peroxide	H_2O_2	$\frac{H_2O_2}{2} = HO$
Molar Mass	34.02 g/mol	17.01 g/mol

The MF subscripts has a common divisible number, 2. Therefore, each subscript was divided by 2 in order to obtain the EF.

Calculate the ratio of the molar masses:

$$\frac{\text{Molar mass of MF}}{\text{Molar Mass of EF}} = \frac{\mathbf{34.02}}{\mathbf{17.01}} = \underline{\hspace{2cm}}$$

What do you notice about the ratio of the molar mass and common divisible number?

Critical Thinking: If you knew the empirical formula and molar mass of your molecular formula, how would you try to find the Molecular formula?

Practice:

1. Complete the table below by writing the empirical formula for each molecular formula.

Molecular Formula	Empirical Formula
P_4O_{10}	
N_2O_5	
$C_{12}H_{27}$	
$C_{20}H_{25}O_{10}$	

2. A compound has an empirical formula of CH_2 and a molecular mass of 42.0g/mol. Determine its molecular formula.
3. The empirical formula was determined to be PBr_5 . What is the molecular formula if the molar mass of the molecular formula was found to be 431 g/mol.
4. A combustion analysis gives the following empirical formula of C_2H_4O . Determine the molecular formula knowing that the molecular mass = 132.16g/mol.
5. Naphthalene is a carbon and hydrogen containing compound often used in moth balls. The empirical formula is C_5H_4 and its molar mass is 128.16g/mol. Find the molecular formula.