Unit 7 Chemical Formulas and Reactions **Name _____**

Intro to Chemical Formulas **Block _____**

Types of Chemical Formulas

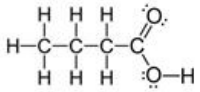
A **Molecular Formula** describes the exact number and type of atoms in a single molecule of a compound. The number of atoms is represented using subscripts. The molecular formula for sodium sulfate is **Na_2SO_4** and for acetic acid it is **$C_2H_4O_2$**.

An **Empirical Formula** represents the simplest whole-integer ratio of atoms in a compound. The molecular formula for a compound can be the same as or a multiple of the compound's empirical formula. The empirical formula stays the same for ionic compounds, such as sodium sulfate (**Na_2SO_4),** but it reduces to the lowest ratio for covalent compounds, such as acetic acid (**$C_1H_2O_1$**).

A **Structural Formula** shows the number of atoms and their exact arrangement in the molecule. The structural formula stays the same for ionic compounds, such as sodium sulfate (**Na_2SO_4),** but it changes for organic compounds, such as acetic acid (**CH_3COOH**).

For more information visit: https://courses.lumenlearning.com/boundless-chemistry/chapter/chemical-formulas/

Write the molecular, empirical, and structural formulas for butanoic acid below:

 **Butanoic acid**	**Molecular Formula**	**Empirical Formula**	**Structural Formula**

Empirical Formulas can be calculated by using the **Percent Composition** of each element in a compound**.** For instance, suppose a chemist used **Combustion Analysis** to determine that a sample of **butanoic acid** was composed of **54.529% C**, **9.152% H**, and **36.319% O**. Follow the steps below to calculate its empirical formula.

Percent Composition	Change to Grams	÷ Molar Mass	= Moles	÷ Smallest Moles	= Subscripts
54.529 % C		÷	=	÷	=
9.152 % H		÷	=	÷	=
36.319 % O		÷	=	÷	=

Write the **Empirical Formula** for butanoic acid using the subscripts calculated above. _____ Compare this to the empirical formula for butanoic acid written in the first table above.

The **Molecular Formula** can be calculated by scaling up the empirical formula proportionately based on the measured molecular mass of the compound.

Given the **Empirical Formula** of **$C_2H_4O_1$** and the **molecular mass of 88 g/mol** to calculate the molecular formula for butanoic acid. Compare it to the molecular formula shown above.

Follow these steps to determine the molecular formula.

Step 1: Calculate the empirical mass using atomic masses from periodic table.

Step 2: Divide molecular mass by empirical mass to determine the scale factor.

Step 3: Multiply subscripts in empirical formula by scale factor to determine subscripts in molecular formula.

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1. The main ingredient in the antacid called Tums is composed of 40.043% Calcium, , 12.000% Carbon, and 47.957% Oxygen. Write the empirical formula and name the compound.

Element	Change % to Grams	÷ Molar Mass	= Moles	÷ Smallest Moles	= Subscripts
Ca	g	÷	=	÷	=
C	g	÷	=	÷	=
O	g	÷	=	÷	=

Empirical Formula = _____ **Name of Compound = _____**

2. Using Combustion Analysis, a chemist determines that Nicotine, the addictive drug in cigarettes, contains 74.0% carbon, 8.65% hydrogen, and 17.35% nitrogen. Determine the empirical formula for nicotine.

Element	Change % to Grams	÷ Molar Mass	= Moles	÷ Smallest Moles	= Subscripts
C	g	÷	=	÷	=
H	g	÷	=	÷	=
N	g	÷	=	÷	=

Empirical Formula = _____

Calculating Molecular Formulas. ***Show your work.***

1. The empirical formula of a substance is $C_4H_5ON_2$ and the molecular mass is 194.19 grams per mole. Determine its molecular formula.

2. The empirical formula of a substance is CH_2O and its molecular mass is 180 g/mol. What is its molecular formula?

3. Methylpropionylacetate is a carboxylic acid anion derived from a hexanoate. Its empirical formula is C_2H_3O and its molecular mass is 129.13 g/mol. Determine its molecular formula.