

## Empirical and Molecular Formulas

Empirical formula –

Molecular formula –

The molecular formula can also be the same as the empirical formula or any multiple of the empirical formula.

Recognizing empirical and molecular formulas:

Na<sub>2</sub>SO<sub>4</sub> \_\_\_\_\_      H<sub>2</sub>O<sub>2</sub> \_\_\_\_\_      C<sub>6</sub>H<sub>12</sub>O<sub>6</sub> \_\_\_\_\_

H<sub>2</sub>O \_\_\_\_\_      CH<sub>2</sub>O \_\_\_\_\_      Ca(OH)<sub>2</sub> \_\_\_\_\_

Calculating empirical formulas:

Step 1:	Change the number of grams given to moles by using the atomic mass of each element. Use at least 4 significant figures!
Step 2:	Determine the mole ratio by dividing each number of moles by the smallest number of moles. If this does produce whole number ratios of moles, multiply all mole ratios by a whole number so that you do have whole numbers.
Step 3:	Use the ratio as subscripts in the formula. The elements usually appear in the problem in the same order that they should appear in the formula.

Example 1: A compound is 12.69% aluminum, 19.73% nitrogen, and 67.57% oxygen. What is the empirical formula of the sample?

Example 2: A sample of a compound contains 171.0 grams of chromium and 79.0 grams is oxygen. Calculate the empirical formula of this compound.

In general:                    **molecular formula = (empirical formula) × n**

Solve for n:                    
$$n = \frac{\text{molecular formula mass}}{\text{empirical formula mass}}$$

Once the value of 'n' is known simply multiply the subscripts in the empirical formula by 'n' to obtain the correct subscripts for the molecular formula.

Example 1: Hydrazine (a chemical used to treat waste water) has a molecular mass of 32.0 g/mol. The ratio of  $\text{NH}_2$ . What is the molecular formula of hydrazine?

Example 2: Most all sugars have an empirical formula of  $\text{C}_1\text{H}_2\text{O}_1$ . If the molecular mass of an unknown sugar is 180 grams, what is the molecular formula for the unknown sugar?

### **HOMEWORK: Empirical and Molecular Formula**

1. Find the empirical formula for a sample of 25.9 g N and 74.1 g O.
2. The empirical formula for ethylene is  $\text{CH}_2$ . Find the molecular formula if the molecular mass 28.1 g/mol.
3. If caffeine is 49.5% carbon, 5.20 % hydrogen, 16.5% oxygen, and 28.9% nitrogen. What is the molecular formula if the molar mass of caffeine is 194.1 g/mol?