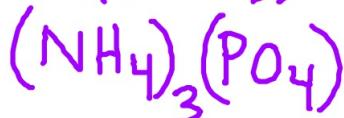


Percent Composition

% Composition Formula:

$$\frac{\text{mass element}}{\text{mass compound}} \times 100$$

Example 1: What percentage of ammonium phosphate is hydrogen?



$$\text{N} = 3 \times 14.01 = 42.03$$

$$\text{H} = 12 \times 1.01 = 12.12$$

$$\text{P} = 1 \times 30.97 = 30.97$$

$$\begin{aligned}\text{O} &= 4 \times 16 = + 64 \\ &\hline 149.12\end{aligned}$$

$$\% \text{ H} = \frac{\text{mass H}}{\text{mass } (\text{NH}_4)_3\text{PO}_4} \times 100$$

$$\% \text{ H} = \frac{12.12}{149.12} \times 100$$

$$\boxed{\% \text{ H} = 8.13 \%}$$

Example 2: Which of the following compounds contains the greatest percentage of iron by mass?

$$(a) \text{FeCl}_3 \quad \% \text{ Fe} = \frac{\text{mass Fe}}{\text{mass FeCl}_3} \times 100 = \frac{55.85}{162.2} \times 100 = 34.43 \%$$

$$(b) \text{FeO} \quad \% \text{ Fe} = \frac{\text{mass Fe}}{\text{mass FeO}} \times 100 = \frac{55.85}{71.85} \times 100 = 77.73 \%$$

$$(c) \text{Fe}_2\text{O}_3 \quad \% \text{ Fe} = \frac{\text{mass 2 Fe}}{\text{mass Fe}_2\text{O}_3} \times 100 = \frac{(2 \times 55.85)}{159.7} \times 100 = 69.94 \%$$

$$(d) \text{FeCl}_2 \quad \% \text{ Fe} = \frac{\text{mass Fe}}{\text{mass FeCl}_2} \times 100 = \frac{55.85}{126.75} \times 100 = 44.06 \%$$

Molecular Formula vs Empirical Formula

An empirical formula is: the simplest/reduced ratio of atoms

A molecular formula is: the actual # of atoms in the molecule

CH_2O is a Empirical

$\text{C}_6\text{H}_{12}\text{O}_6$ is a molecular

- Empirical Formula is a reduced form of Molecular formula
- Different compounds can have the same empirical formula but different molecular formulas.

Empirical Formulas

Step 1: Change % sign to g - if you are given grams, skip this step

Step 2: Convert masses to moles using molar mass

Step 3: Divide all # of moles by the smallest value

Step 4: If dividing gave you .5, then multiply by 2

Step 5: If dividing gave you .3 or .7, then multiply by 3

Step 6: If step 5 or 6 do not apply, then Round step 3 values to a whole number

Step 7: Once you know the whole, place them as subscripting the formula
ratio

Practice Problems:

1. A compound contains 3.26g of arsenic and 1.04g of oxygen. What is the empirical formula?

$$\frac{3.26 \text{ g As}}{74.92 \text{ g As}} = 0.0435 \text{ mol As} / 0.0435 = 1 \times 2 = 2 \text{ mol As}$$

$$\frac{1.04 \text{ g O}}{16 \text{ g O}} = 0.065 \text{ mol O} / 0.0435 = 1.5 \times 2 = 3 \text{ mol O}$$

Empirical = As_2O_3

2. Find the empirical formula of a compound that is 33.38% Na, 22.65% S, and 44.90% O.

$$33.38\% \text{ Na} = \frac{33.38 \text{ g Na}}{22.99 \text{ g Na}} \Big| \frac{1 \text{ mol Na}}{1 \text{ mol Na}} = 1.451935 \text{ mol Na}$$

$$\qquad\qquad\qquad = \frac{1.451935 \text{ mol Na}}{0.7062675} = 2 \text{ mol Na}$$

$$22.65\% \text{ S} = \frac{22.65 \text{ g S}}{32.07 \text{ g S}} \Big| \frac{1 \text{ mol S}}{1 \text{ mol S}} = 0.7062675 \text{ mol S}$$

$$44.90\% \text{ O} = \frac{44.90 \text{ g O}}{16 \text{ g O}} \Big| \frac{1 \text{ mol O}}{1 \text{ mol O}} = 2.80625 \text{ mol O}$$

$$\qquad\qquad\qquad = \frac{2.80625 \text{ mol O}}{0.7062675} = 4 \text{ mol O}$$

Empirical = Na_2SO_4

3. What is the empirical formula of a compound that is 62.10% C, 13.80% H, and 24.10% N?

$$62.10\% \text{ C} = \frac{62.10 \text{ g C}}{12.01 \text{ g C}} \Big| \frac{1 \text{ mol C}}{1 \text{ mol C}} = 5.17069 \text{ mol C}$$

$$\qquad\qquad\qquad = \frac{5.17069 \text{ mol C}}{1.720199857} = 3 \text{ mol C}$$

$$13.80\% \text{ H} = \frac{13.80 \text{ g H}}{1.01 \text{ g H}} \Big| \frac{1 \text{ mol H}}{1 \text{ mol H}} = 13.663366 \text{ mol H}$$

$$\qquad\qquad\qquad = \frac{13.663366 \text{ mol H}}{1.720199857} = 8 \text{ mol H}$$

$$24.10\% \text{ N} = \frac{24.10 \text{ g N}}{14.01 \text{ g N}} \Big| \frac{1 \text{ mol N}}{1 \text{ mol N}} = 1.720199857 \text{ mol N}$$

$$\qquad\qquad\qquad = \frac{1.720199857 \text{ mol N}}{1.720199857} = 1 \text{ mol N}$$

Empirical = $\text{C}_3\text{H}_8\text{N}$

Molecular Formulas

To find the molecular formula you must:

1. Find the Empirical formula if not given
2. Determine the molar mass of the empirical formula
3. MM molecular formula = "X"
MM empirical formula
4. Multiply each subscript in the empirical formula by "X"

Practice Problems

1. The empirical formula of a compound is CH; the molecular molar mass is 78.11 g/mol. What is its molecular formula?

$$\text{Empirical} = \text{CH}$$

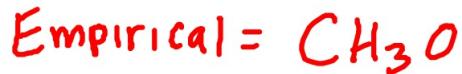
$$\text{MM}_{\text{MF}} = 78.11$$

$$\text{MM}_{\text{EF}} = 13.02$$

$$\frac{\text{MM}_{\text{MF}}}{\text{MM}_{\text{EF}}} = \frac{78.11}{13.02} = 6$$

$$\text{Molecular} = (\text{CH}) \times 6 = \boxed{\text{C}_6\text{H}_6}$$

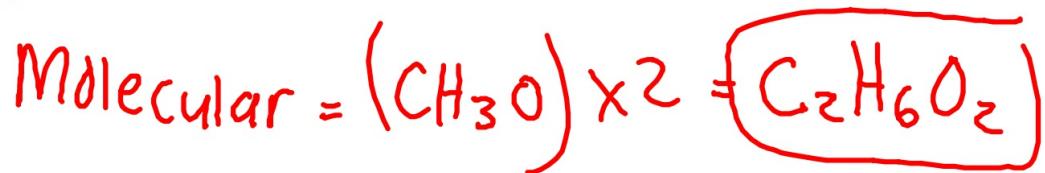
2. A compound has an empirical formula of CH_3O and a molecular mass of 62.00 g/mol. What is its molecular formula?



$$\text{MM}_{\text{MF}} = 62.00 \text{ g/mol}$$

$$\text{MM}_{\text{EF}} = (12.01) + (3 \times 1.01) + (16) = 31.04$$

$$\frac{\text{MM}_{\text{MF}}}{\text{MM}_{\text{EF}}} = \frac{62.00}{31.04} = 2$$



3. A compound is 26.70% C, 2.20% H, and 71.10% O. Its molecular mass is 90.00 g/mol. What is its molecular formula?

Summary

Determine the molecular and empirical formula for each:

