

①

* change percents into grams

Empirical and Molecular Formula Practice Problems

1. A compound contains 40.0% carbon, 6.7% hydrogen, and 53.3% oxygen by mass. Determine the empirical formula of the compound.

② grams → mol

C $\frac{40.0 \text{ g C} \times \frac{1 \text{ mol C}}{12.011 \text{ g C}}}{3.33} = 3.33$

smallest number! divide w/ others

$\frac{3.33}{3.33} = 1$

H $\frac{6.7 \text{ g H} \times \frac{1 \text{ mol H}}{1.0079 \text{ g H}}}{3.33} = 6.6$

$\frac{6.6}{3.33} = 1.98 \rightarrow 2$



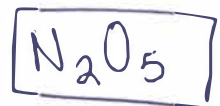
O $\frac{53.3 \text{ g O} \times \frac{1 \text{ mol O}}{15.999 \text{ g O}}}{3.33} = 3.33$

$\frac{3.33}{3.33} = 1$

2. A sample of an unknown compound is found to contain 2.5 g of nitrogen and 7.1 g of oxygen. Determine the empirical formula.

N $\frac{2.5 \text{ g N} \times \frac{1 \text{ mol N}}{14.007 \text{ g N}}}{0.18} = 0.18$

$\frac{0.18}{0.18} = 1 (2) = 2$

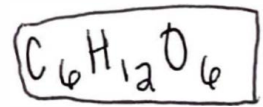


O $\frac{7.1 \text{ g O} \times \frac{1 \text{ mol O}}{15.999 \text{ g O}}}{0.18} = 0.44$

$\frac{0.44}{0.18} = 2.5 (2) = 5$

3. A compound has an empirical formula of CH₂O and a molar mass of 180.2 g/mol. Determine the molecular formula.

$n \left(\frac{\text{empirical formula}}{\text{from periodic table}} \right) = \frac{\text{molar mass}}{\text{\% composition from given}}$



①
C (1) = 12.011
H (2) = 2.01588
O (1) = 15.999

$30.02588 \rightarrow 30.026 \text{ g CH}_2\text{O}$

②

$n(\text{CH}_2\text{O}) = \frac{180.2 \text{ g/mol}}{30.026 \text{ g}} = 6$

$n = 6 \text{ mols}$

③
C (1) * 6 = 6
H (2) * 6 = 12
O (1) * 6 = 6

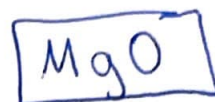
$$\text{Mg} = 5.0 \text{ g}$$

$$8.3 \text{ MgO} - 5.0 \text{ g Mg} = 3.3 \text{ g O}$$

4. A 5.0 g sample of magnesium reacts with oxygen to form 8.3 g of magnesium oxide. Determine the empirical formula of magnesium oxide.

$$\text{Mg} \quad \frac{5.0 \text{ g Mg}}{24.305 \text{ g/mol}} \times \frac{1 \text{ mol Mg}}{1} = \frac{0.21}{0.21} = 1$$

$$\text{O} \quad \frac{3.3 \text{ g O}}{15.999 \text{ g/mol}} \times \frac{1 \text{ mol O}}{1} = \frac{0.21}{0.21} = 1$$



* need to solve empirical first *

5. A compound contains 85.6% carbon and 14.4% hydrogen by mass. If its molar mass is 56.1 g/mol, determine its molecular formula.

$$n (\text{empirical formula}) = \frac{\text{molar mass}}{\% \text{ composition}}$$

$$\begin{array}{r} \text{C (1)} = 12.011 \\ \text{H (2)} = 2.01588 \\ \hline 14.02688 \\ \boxed{14.027} \end{array}$$

empirical:

molecular

$$\text{C} \quad \frac{85.6 \text{ g C}}{12.011 \text{ g/mol}} \times \frac{1 \text{ mol C}}{1} = \frac{7.13}{7.13} = 1$$

$$\text{H} \quad \frac{14.4 \text{ g H}}{1.00794 \text{ g/mol}} \times \frac{1 \text{ mol H}}{1} = \frac{14.3}{7.13} = 2$$



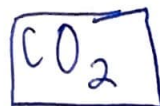
$$n (\frac{14.027 \text{ g}}{14.027 \text{ g/mol}}) = \frac{56.1 \text{ g/mol}}{14.027 \text{ g/mol}}$$

$$n = 4 \quad \begin{array}{l} \text{C (1)} \times 4 \\ \text{H (2)} \times 4 \end{array} = \boxed{\text{C}_4\text{H}_8}$$

6. A compound contains 27.3% carbon, 72.7% oxygen. Determine the empirical formula. If the ratio comes out as C₁O_{1.5}, how would you adjust it to a whole-number empirical formula?

$$\text{C} \quad \frac{27.3 \text{ g C}}{12.011 \text{ g/mol}} \times \frac{1 \text{ mol C}}{1} = \frac{2.27}{2.27} = 1$$

$$\text{O} \quad \frac{72.7 \text{ g O}}{15.999 \text{ g/mol}} \times \frac{1 \text{ mol O}}{1} = \frac{4.54}{2.27} = 2$$



you would multiply to the nearest whole number. For example,

$$\text{C}_{10.5}\text{O}_{15} \times 2 = \boxed{\text{C}_{21}\text{O}_{30}}$$