

## EMPIRICAL AND MOLECULAR FORMULA WORKSHEET

1. An oxide of chromium is found to have the following % composition: 68.4 % Cr and 31.6 % O. Determine this compound's empirical formula.
2. The percent composition of a compound was found to be 63.5 % silver, 8.2 % nitrogen, and 28.3 % oxygen. Determine the compound's empirical formula.
3. A 170.00 g sample of an unidentified compound contains 29.84 g sodium, 67.49 g chromium, and 72.67 g oxygen. What is the compound's empirical formula?
4. A 60.00 g sample of tetraethyl lead, a gasoline additive, is found to contain 38.43 g lead, 17.83 g carbon, and 3.74 g hydrogen. Find its empirical formula.
5. A compound containing 5.9265 % H and 94.0735 % O has a molar mass of 34.01468 g/mol. Determine the empirical and molecular formula of this compound.

6. The empirical formula for trichloroisocyanuric acid, the active ingredient in many household bleaches, is  $\text{OCNCl}$ . The molar mass of this compound is 232.41 g/mol. What is the molecular formula of trichloroisocyanuric acid?
  
7. Determine the molecular formula of a compound with an empirical formula of  $\text{NH}_2$  and a formula mass of 32.06 amu.
  
8. The empirical formula of a hydrocarbon (compound that contains only C and H) is found to be  $\text{CH}$ . Laboratory procedures have found that the molar mass of the compound is 78 g/mol. What is the molecular formula of this compound?
  
9. The molar mass of nicotine is 162.1 g/mol. It contains 74.0 % carbon, 8.7 % hydrogen, and 17.3 % nitrogen. Determine nicotine's empirical formula and molecular formula.
  
10. Phenyl magnesium bromide is used as a Grignard reagent in organic synthesis. Determine its empirical and molecular formula if its molar mass is 181.313 g/mol and it contains 39.7458 % C, 2.77956 % H, 13.4050 % Mg, and 44.0697 % Br.

key

## EMPIRICAL AND MOLECULAR FORMULA WORKSHEET

1. An oxide of chromium is found to have the following % composition: 68.4 % Cr and 31.6 % O. Determine this compound's empirical formula.

$$\begin{array}{l} \text{Cr} \quad \frac{68.4 \text{ g} / 1 \text{ mol}}{52 \text{ g}} = \frac{1.315}{1.315} = 1 \\ \text{O} \quad \frac{31.6 \text{ g} / 1 \text{ mol}}{16 \text{ g}} = \frac{1.975}{1.315} = 1.5 \end{array} \quad \begin{array}{l} \text{Cr}_1 \text{O}_{1.5} \\ \boxed{\text{Cr}_2\text{O}_3} \end{array}$$

2. The percent composition of a compound was found to be 63.5 % silver, 8.2 % nitrogen, and 28.3 % oxygen. Determine the compound's empirical formula.

$$\begin{array}{l} \text{Ag} \quad \frac{63.5 \text{ g} / 1}{107.87} = \frac{0.589}{0.589} = 1 \\ \text{N} \quad \frac{8.2 \text{ g} / 1}{14.01} = \frac{0.585}{0.585} = 1 \\ \text{O} \quad \frac{28.3 \text{ g} / 1}{16 \text{ g}} = \frac{1.769}{0.585} = 3 \end{array} \quad \boxed{\text{AgNO}_3}$$

3. A 170.00 g sample of an unidentified compound contains 29.84 g sodium, 67.49 g chromium, and 72.67 g oxygen. What is the compound's empirical formula?

$$\begin{array}{l} \text{Na:} \quad \frac{29.84}{170.00} = \frac{17.55}{22.99} = \frac{0.76}{0.76} = 1 \\ \text{Cr} \quad \frac{67.49}{170.00} = \frac{39.7}{52} = \frac{0.76}{0.76} = 1 \\ \text{O} \quad \frac{72.67}{170.00} = \frac{42.7}{16} = \frac{2.7}{0.76} = 3.5 \end{array} \quad \begin{array}{l} \text{NaCrO}_{3.5} \\ \boxed{\text{Na}_2\text{Cr}_2\text{O}_7} \end{array}$$

4. A 60.00 g sample of tetraethyl lead, a gasoline additive, is found to contain 38.43 g lead, 17.83 g carbon, and 3.74 g hydrogen. Find its empirical formula.

$$\begin{array}{l} \text{Pb} \quad \frac{38.43}{60.00} = \frac{64.05}{207.2} = \frac{0.3}{0.3} = 1 \\ \text{C} \quad \frac{17.83}{60.00} = \frac{29.72}{12.01} = \frac{2.47}{0.3} = 8.2 \\ \text{H} \quad \frac{3.74}{60.00} = \frac{6.23}{1.01} = \frac{6.17}{0.3} = 21 \end{array} \quad \boxed{\text{PbC}_8\text{H}_{21}}$$

5. A compound containing 5.9265 % H and 94.0735 % O has a molar mass of 34.01468 g/mol. Determine the empirical and molecular formula of this compound.

$$\begin{array}{l} \text{H} \quad \frac{5.9265 \text{ g} / 1 \text{ mol}}{1.01 \text{ g}} = \frac{5.87}{5.87} \\ \text{O} \quad \frac{94.0735 \text{ g} / 1 \text{ mol}}{16.00 \text{ g}} = \frac{5.88}{5.87} \end{array} \quad \begin{array}{l} \text{E: } \text{HO} \\ \text{M: } \text{H}_2\text{O}_2 \end{array} \quad \begin{array}{l} \text{EFM} = 17.01 \\ \frac{34}{17.01} = 2 \end{array}$$

# Empirical and Molecular Formulas Worksheet

## Objectives:

- be able to calculate empirical and molecular formulas

## Empirical Formula

- 1) What is the empirical formula of a compound that contains 0.783g of Carbon, 0.196g of Hydrogen and 0.521g of Oxygen?
- 2) What is empirical formula of a compound which consists of 89.14% Au and 10.80% of O?
- 3) What is empirical formula if compound consists of 21.2%N, 6.1%H, 24.2%S and 48.5%O?

## Molecular Formula

- 4) Empirical formula of a substance is  $\text{CH}_2\text{O}$ . Molar mass is 180. What is the molecular formula?
- 5) Sample (3.585g) contains 1.388g of C, 0.345g of H, 1.850g O and its molar mass is 62g. What is molecular formula of this substance?

- |    |                                     |
|----|-------------------------------------|
| 1. | $\text{C}_2\text{H}_6\text{O}$      |
| 2. | $\text{Au}_2\text{O}_3$             |
| 3. | $\text{N}_2\text{H}_8\text{SO}_4$   |
| 4. | $\text{C}_6\text{H}_{12}\text{O}_6$ |
| 5. | $\text{C}_2\text{H}_6\text{O}_2$    |

# Empirical and Molecular Formulas Worksheet

Key

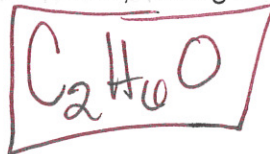
## Objectives:

- be able to calculate empirical and molecular formulas

## Empirical Formula

1) What is the empirical formula of a compound that contains 0.783g of Carbon, 0.196g of Hydrogen and 0.521g of Oxygen?

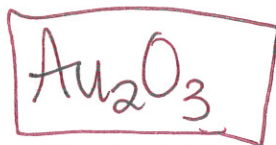
$$\begin{array}{l}
 \text{C} \quad \frac{0.783\text{g C}}{12.01\text{g}} = \frac{0.065}{0.033} = 1.96 \quad 2 \\
 \text{H} \quad \frac{0.196\text{g H}}{1.01\text{g}} = \frac{0.194}{0.033} = 5.88 \quad 6 \\
 \text{O} \quad \frac{0.521\text{g O}}{16.00\text{g}} = \frac{0.033}{0.033} = 1 \quad 1
 \end{array}$$



2) What is empirical formula of a compound which consists of 89.14% Au and 10.80% of O?

$$\text{Au} \quad \frac{89.14\text{g}}{196.97} = \frac{0.45}{0.45} = 1 \quad \text{AuO}_{1.5}$$

$$\text{O} \quad \frac{10.80\text{g}}{16\text{g}} = \frac{0.675}{0.45} = 1.5$$



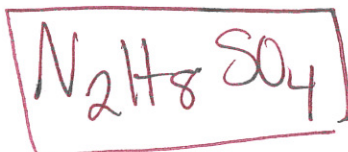
3) What is empirical formula if compound consists of 21.2%N, 6.1%H, 24.2%S and 48.5%O?

$$\text{N} \quad \frac{21.2\text{g}}{14.01} = 1.5 \quad \cdot \quad 2$$

$$\text{H} \quad \frac{6.1\text{g}}{1.01\text{g}} = 6.03 \quad \cdot \quad 8$$

$$\text{S} \quad \frac{24.2\text{g}}{32} = 0.75 \quad \cdot \quad 1$$

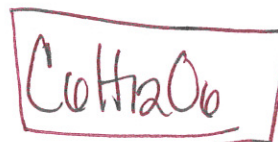
$$\text{O} \quad \frac{48.5\text{g}}{16.00\text{g}} = 3.03 \quad \cdot \quad 4$$



## Molecular Formula

4) Empirical formula of a substance is  $\text{CH}_2\text{O}$ . Molar mass is 180. What is the molecular formula?

$$\text{EFM} = (12 + 2 \cdot 0.2 + 16) = \frac{180}{30.02} = 6$$



5) Sample (3.585g) contains 1.388g of C, 0.345g of H, 1.850g O and its molar mass is 62g. What is molecular formula of this substance?

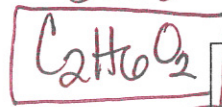
$$\text{C} \quad \frac{1.388}{3.585} \rightarrow 38.7\% \rightarrow \frac{38.7\text{g}}{12.01\text{g}} = \frac{3.22}{3.22} = 1$$

$$\text{H} \quad \frac{0.345}{3.585} \rightarrow \frac{9.62\text{g}}{1.01\text{g}} = \frac{9.52}{3.22} = 3$$

$$\text{O} \quad \frac{1.850}{3.585} \rightarrow \frac{51.6\text{g}}{16\text{g}} = \frac{3.22}{3.22} = 1$$



$$\frac{62}{31.03} = 2$$



- |    |                                     |
|----|-------------------------------------|
| 1. | $\text{C}_2\text{H}_6\text{O}$      |
| 2. | $\text{Au}_2\text{O}_3$             |
| 3. | $\text{N}_2\text{H}_8\text{SO}_4$   |
| 4. | $\text{C}_6\text{H}_{12}\text{O}_6$ |
| 5. | $\text{C}_2\text{H}_6\text{O}_2$    |