

Example 2. The alcohol 2,5-hexanediol is composed of 61% Carbon, 11.9% Hydrogen, and 27.1% O. What is the molecular formula of the substance if its molar mass is 118g/mol?

Step 1. Determine the empirical formula.

- We assume that the sample has a mass of 100g. This means that 61g of the sample is Carbon, 11.9g is Hydrogen and 27.1g is Oxygen.
- We then convert all given masses to moles using the molar mass of each element.

$$\text{For Carbon} \quad (61\text{g C}) \left(\frac{1\text{mol C}}{12.01\text{g}} \right) = 5.08 \text{ mol C}$$

$$\text{For Hydrogen} \quad (11.9\text{g H}) \left(\frac{1\text{mol H}}{1.00\text{g}} \right) = 11.9 \text{ mol H}$$

$$\text{For Oxygen} \quad (27.1\text{g O}) \left(\frac{1\text{mol O}}{16.00\text{g}} \right) = 1.69 \text{ mol O}$$

- We divide the molar amounts by the smallest mole calculated. We can see from the results above that the smallest mole amount calculated is 1.69. We divide all molar amounts by this number.

$$\text{For carbon} \quad \frac{5.08 \text{ mol}}{1.69 \text{ mol}} = 3.01$$

$$\text{For Hydrogen} \quad \frac{11.9 \text{ mol}}{1.69 \text{ mol}} = 7.04$$

$$\text{For Oxygen} \quad \frac{1.69 \text{ mol}}{1.69 \text{ mol}} = 1.00$$

- Round the mole ratios to the nearest whole number and write the empirical formula.

Mole ratio C = 3

Mole ratio H = 7

Mole ratio O = 1

The empirical formula of 2,5-hexanediol is $\text{C}_3\text{H}_7\text{O}$

Step 2. We need to determine the empirical molar mass of the substance.

Element in the compound	Molar mass of the element	Subscript	Total mass contributed by the element
Carbon	12.01g/mol	3	36.03g/mol
Hydrogen	1.00g/mol	7	7.00g/mol
Oxygen	16.00g/mol	1	16.00g/mol
Molar mass of CH_2			59.03g/mol

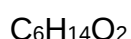
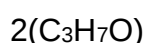
Step 4. Divide the molecular molar mass by the empirical molar mass to get the whole number multiple.

$$\text{Whole number multiple} = \frac{\text{molecular molar mass}}{\text{empirical molar mass}}$$

$$\text{Whole number multiple} = \frac{118\text{g/mol}}{59.03\text{g/mol}}$$

$$\text{Whole number multiple} = 2$$

Step 5. Multiply the subscript of each element in the empirical formula by the whole number ratio.



The molecular formula of the substance is $\text{C}_6\text{H}_{14}\text{O}_2$.