



# Determining Empirical and Molecular Formula

## Answers

- 1) A compound with an empirical formula of  $C_4H_4O$  and a molar mass of 136 grams per mole. What is the molecular formula of this compound?

$$\begin{aligned}\text{Empirical formula mass} &= (4 \times 12.01 \text{ g/mol}) + (4 \times 1.01 \text{ g/mol}) + (1 \times 16.00 \text{ g/mol}) \\ &= 68.08 \text{ g/mol}\end{aligned}$$

$$\text{Ratio} = \text{Molar mass}/\text{Empirical formula mass} = 136 \text{ g/mol}/ 68.08 \text{ g/mol} = 2$$

$$\text{Molecular formula} = (C_4H_4O)_2 = C_8H_8O_2$$

- 2) A compound with an empirical formula of  $CFBrO$  and a molar mass of 254.7 grams per mole. What is the molecular formula of this compound?

$$\text{Empirical formula mass} = (1 \times 12.01) + (1 \times 19) + (1 \times 79.9) + (1 \times 16) = 127 \text{ g/mol}$$

$$\text{Ratio} = \text{Molar mass}/\text{Empirical formula mass} = 254.7 \text{ g/mol}/ 127 \text{ g/mol} = 2$$

$$\text{Molecular formula} = CFBrO = (CFBrO)_2$$

- 3) A compound with an empirical formula of  $C_2H_8N$  and a molar mass of 46 grams per mole. What is the molecular formula of this compound?

$$\text{Empirical formula mass} = (2 \times 12.01 \text{ g/mol}) + (8 \times 1.01 \text{ g/mol}) + (1 \times 14.00 \text{ g/mol}) = 46 \text{ g/mol}$$

$$\text{Ratio} = \text{Molar mass}/\text{Empirical formula mass} = 46 \text{ g/mol}/ 46 \text{ g/mol} = 1$$

$$\text{Molecular formula} = C_2H_8N$$

- 4) A well-known reagent in analytical chemistry, dimethylglyoxime, has the empirical formula  $C_2H_4NO$ . If its molar mass is 116.1 g/mol, what is the molecular formula of the compound?

$$\begin{aligned}\text{Empirical formula mass} &= (2 \times 12.01 \text{ g/mol}) + (4 \times 1.01 \text{ g/mol}) + (1 \times 14.00 \text{ g/mol}) + \\ &(1 \times 16.00 \text{ g/mol}) = 58.6 \text{ g/mol}\end{aligned}$$

$$\text{Ratio} = \text{Molar mass}/\text{Empirical formula mass} = 116.1 \text{ g/mol}/ 58 \text{ g/mol} = 2$$

$$\text{Molecular formula} = (C_2H_4NO)_2 = C_4H_8N_2O_2$$

- 4) Rubbing alcohol contained 60.0 % carbon and 13.4 % hydrogen, and the remaining mass was due to oxygen. What is the empirical formula of rubbing alcohol?

$$\text{Percentage of O} = 100 - (60 + 13.4) = 26.6\%$$

$$\text{Moles of C} = 60 \text{ g}/12.01 \text{ g/mol} = 5 \text{ mol}/1.67 \text{ mol} = 3$$

$$\text{Moles of H} = 13.4 \text{ g}/1.01 \text{ g/mol} = 13.27 \text{ mol}/1.67 \text{ mol} = 8$$

$$\text{Moles of O} = 26.6 \text{ g}/16.00 \text{ g/mol} = 1.67 \text{ mol}/1.67 \text{ mol} = 1$$

$$\text{Empirical formula} = C_3H_8O$$