

Exercise walk-through

Elemental Composition of Pure Substances ■ 1.3

eXercise

You must be able to

- calculate the **percent composition** 百分组成 by mass of each element
- find an **empirical formula** 实验式 from mass percentages
- find a **molecular formula** 分子式 from the empirical formula and molar mass
- convert masses to moles and divide by the smallest

Method — Percent composition

$$\% \text{ element} = \frac{\text{mass of that element}}{\text{total mass}} \times 100\%.$$

In water ($M = 18$), oxygen is $16/18 \times 100 \approx 89\%$.

Method — Empirical formula

Convert each element's mass to moles, then divide by the smallest. For 40% C, 6.7% H, 53.3% O (per 100 g): $C = 3.33$, $H = 6.7$, $O = 3.33$ mol; dividing by 3.33 gives CH_2O .

Method — Molecular formula

Divide the true molar mass by the empirical mass for the multiple n . Glucose: empirical CH_2O (30), molar mass 180, so $n = 6$, giving $\text{C}_6\text{H}_{12}\text{O}_6$.

Practice 2.1 ■ 2 marks

In water (H_2O , $M = 18$), what percent of the mass is oxygen (16)?

Solution 2.1

Method: Percent composition

Worked steps

$$16/18 \times 100 \approx 89\% \quad \text{M1} \quad \text{A1}.$$

Practice 2.2 ■ 1 mark

State what an empirical formula gives.

Solution 2.2

Method: Empirical formula

Worked steps

The simplest whole-number ratio of atoms **B1**.

Practice 2.3 ■ 2 marks

A compound has empirical mass 30 and molar mass 90. Find the multiple n .

Solution 2.3

Method: Molecular formula

Worked steps

$$n = 90/30 = 3 \quad \text{M1} \quad \text{A1}.$$

Practice 2.4 ■ 1 mark

After dividing by the smallest you get a ratio 1 : 1.5. State the whole-number ratio.

Solution 2.4

Method: Empirical formula

Worked steps

2 : 3 (multiply both by 2) **B1**.

Exam-style 3.1 ■ 1 mark

The empirical formula of a compound gives

- A** the exact number of atoms in a molecule
- B** the simplest whole-number ratio of atoms
- C** the molar mass
- D** the percent composition

Solution 3.1

Method: Empirical formula

- A the exact number of atoms in a molecule
- B the simplest whole-number ratio of atoms
- C the molar mass
- D the percent composition



Worked steps

B — the simplest whole-number ratio of atoms.

Exam-style 3.2 ■ 1 mark

A compound is 75% carbon and 25% hydrogen by mass ($C = 12$, $H = 1$). Its empirical formula is

A CH

B CH₂

C CH₄

D C₂H

Solution 3.2

A CH

B CH₂

C CH₄



D C₂H

Worked steps

C — C: $75/12 = 6.25$, H: $25/1 = 25$; ratio 1 : 4, so CH₄.

Exam-style 3.3 ■ 3 marks

A compound is 40% sulfur and 60% oxygen by mass ($S = 32$, $O = 16$).

- (a) Find the empirical formula.
- (b) State the method you used.

Solution 3.3

Worked steps

(a) Per 100 g: $S = 40/32 = 1.25$, $O = 60/16 = 3.75$ mol **M1**; divide by 1.25: S 1, O 3 **M1**; empirical formula SO_3 **A1**. (b) Convert mass percents to moles and divide by the smallest **B1**.

Exam-style 3.4 ■ 1 mark

A compound has empirical formula CH_2 (empirical mass 14) and a molar mass of 56 g/mol.

- (a) Find the multiple n .
- (b) Write the molecular formula.

Solution 3.4

Method: Molecular formula

Worked steps

(a) $n = 56/14 = 4$ **B1**. (b) C_4H_8 **B1**.