

2.3 Formulas

Name: _____ Class: _____ Date: _____

Total: 11 marks**KEY WORDS** empirical 实验式 • molecular 分子式 • equations 方程式 • balanced 配平 • ionic equation 离子方程式

Objective

Build the skills to answer exam questions on **formulas** — writing formulas of ionic compounds, balancing **equations** 方程式 (including **ionic equations** 离子方程式), and finding **empirical** 实验式 and **molecular** 分子式 formulas.

You must be able to:

- write formulas of ionic compounds from ionic charges and oxidation numbers
- write and balance equations (including ionic equations) with state symbols
- calculate empirical and molecular formulas from data

1 Worked examples

■ Ionic formulas



$$A_r = \frac{(75 \times 35) + (25 \times 37)}{100} = 35.5$$

Formulae build from relative atomic masses

The total + charge balances the total – charge. Charges from the group: Group 1 +1, 2 +2, 13 +3, 15 –3, 16 –2, 17 –1. Learn: NO_3^- , CO_3^{2-} , SO_4^{2-} , OH^- , NH_4^+ . E.g. iron(III) oxide = Fe_2O_3 (two Fe^{3+} balance three O^{2-}).

■ Equations and ionic equations

A balanced equation has the same atoms on both sides; add **state symbols** (s, l, g, aq). An **ionic equation** shows only what changes (no **spectator ions** 旁观离子): $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$.

■ Empirical formula

Divide each element's mass (or %) by its $A_r \rightarrow$ moles; divide by the smallest; round to whole numbers. **Example.** 40.0% C, 6.7% H, 53.3% O: moles $3.33 : 6.7 : 3.33 \rightarrow 1 : 2 : 1 \rightarrow \text{CH}_2\text{O}$. With M_r , scale up to the **molecular formula**.

2 Practice

2.1 Write the formula of (a) calcium nitrate and (b) aluminium sulfate. [2]

2.2 Write the ionic equation for the reaction of silver ions with chloride ions to form silver chloride. [1]

3 Exam-style questions

3.1 What is the formula of iron(III) sulfate? [1]

- A FeSO_4
 - B Fe_2SO_4
 - C $\text{Fe}_2(\text{SO}_4)_3$
 - D $\text{Fe}_3(\text{SO}_4)_2$
-

3.2 A compound has empirical formula CH_2 and $M_r = 42$. Its molecular formula is: [1]

- A CH_2
 - B C_2H_4
 - C C_3H_6
 - D C_4H_8
-

3.3 Balance this equation and add state symbols: $\text{Mg} + \text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$. [2]

3.4 A compound contains 2.4 g of carbon, 0.4 g of hydrogen and 3.2 g of oxygen (A_r : C 12, H 1, O 16).

(a) Calculate its empirical formula.

[3]

(b) The M_r of the compound is 60. Deduce its molecular formula.

[1]

Solutions

2.1 (a) $\text{Ca}(\text{NO}_3)_2$; (b) $\text{Al}_2(\text{SO}_4)_3$.

2.2 $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$.

3.1 C. Two Fe^{3+} balance three $\text{SO}_4^{2-} \rightarrow \text{Fe}_2(\text{SO}_4)_3$.

3.2 C. Empirical mass 14; $42/14 = 3 \rightarrow \text{C}_3\text{H}_6$.

3.3 $\text{Mg}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{MgCl}_2(\text{aq}) + \text{H}_2(\text{g})$.

3.4 (a) moles: $\text{C} = 2.4/12 = 0.20$, $\text{H} = 0.4/1 = 0.40$, $\text{O} = 3.2/16 = 0.20$; divide by 0.20 $\rightarrow 1 : 2 : 1$; empirical formula CH_2O .

(b) empirical mass 30; $60/30 = 2 \rightarrow \text{C}_2\text{H}_4\text{O}_2$.