

1.2 Isotopes

Name: _____ Class: _____ Date: _____

Total: 22 marks

KEY WORDS isotope 同位素 • relative atomic mass 相对原子质量 • chemical properties 化学性质
• physical properties 物理性质 • density 密度

Objective

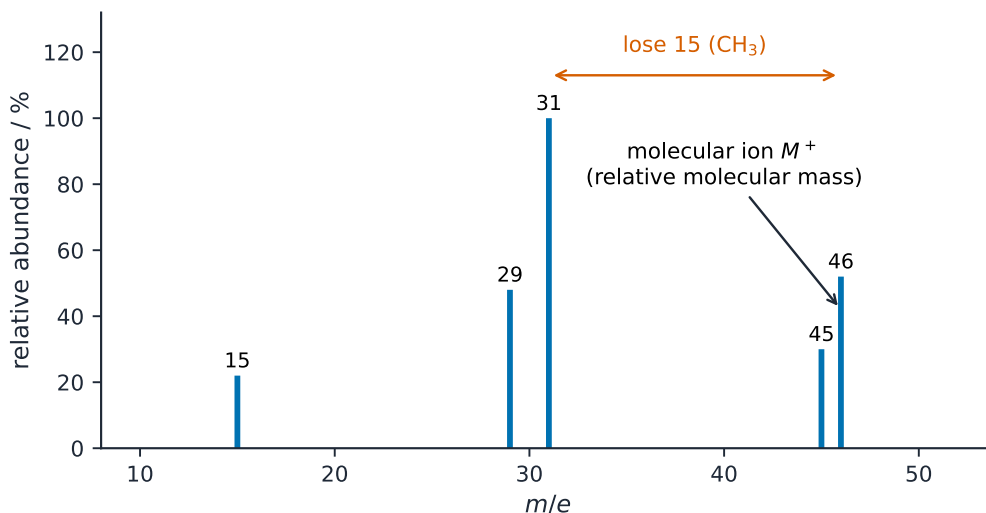
Build the skills to answer exam questions on **isotopes** 同位素 — what they are, the ${}^A_Z\text{X}$ notation, their properties, and calculating **relative atomic mass** 相对原子质量 from isotopic abundances.

You must be able to:

- define isotope and use the ${}^A_Z\text{X}$ notation
- explain why isotopes have the same chemical but different physical properties
- calculate relative atomic mass from isotopic abundances

1 Worked examples

■ What isotopes are



M^+ peak $\approx M_r$ • gaps between peaks = mass of fragments lost

A mass spectrum reveals isotopes and their abundance

Isotopes are atoms of the same element with the same number of **protons** but a different number of **neutrons** — same proton number Z , different nucleon number

A. E.g. chlorine has $^{35}_{17}\text{Cl}$ and $^{37}_{17}\text{Cl}$.

■ **Same chemical, different physical properties**

Chemical properties depend on the **electrons** (especially the outer ones). Isotopes have the same electron arrangement, so they react the same way — **same chemical properties**. Some physical properties depend on **mass**, so they differ: a heavier isotope has a higher **density** 密度.

■ **Relative atomic mass from abundances**

$$A_r = \frac{\sum(\text{isotope mass} \times \% \text{ abundance})}{100}$$

Example. Chlorine is 75% ^{35}Cl and 25% ^{37}Cl :

$$A_r = \frac{(35 \times 75) + (37 \times 25)}{100} = \frac{3550}{100} = 35.5.$$

2 Practice

2.1 Define the term **isotope**.

[2]

2.2 State the number of protons, neutrons and electrons in an atom of $^{37}_{17}\text{Cl}$.

[3]

3 Exam-style questions

3.1 Two isotopes of the same element always have the same:

[1]

A	B
C	D

- A number of neutrons
- B number of protons
- C nucleon number
- D density

3.2 Why do isotopes of an element have identical chemical properties? [1]

A	B
C	D

A they have the same mass

B they have the same number and arrangement of electrons

C they have the same number of neutrons

D they have different densities

3.3 Boron has two isotopes: ^{10}B (20%) and ^{11}B (80%).

(a) Calculate the relative atomic mass of boron. [2]

(b) Explain why ^{11}B is denser than ^{10}B . [1]

3.4 A sample of copper contains 69% ^{63}Cu and 31% ^{65}Cu . Calculate its relative atomic mass to 1 decimal place. [2]

3.5 The mass spectrum of a sample of element **X** gives the following peaks.

m/z	64	66	67	68	70
Relative abundance / %	48.6	27.9	4.1	18.8	0.6

(a) Calculate the relative atomic mass of **X** to three significant figures and identify the element. [4]

(b) A second sample of **X**, taken from a meteorite, gives the same five peaks at different heights. State, with a reason, whether the two samples have the same chemical properties. [2]

(c) Explain why the peak at $m/z = 67$ is so much shorter than the others. [2]

(d) A student writes “the relative atomic mass of **X** is 65.5 g”. Give **two** things wrong with that statement. [2]
