

1.2 Isotopes

Name: _____ Class: _____ Date: _____

Total: 12 marks

Objective

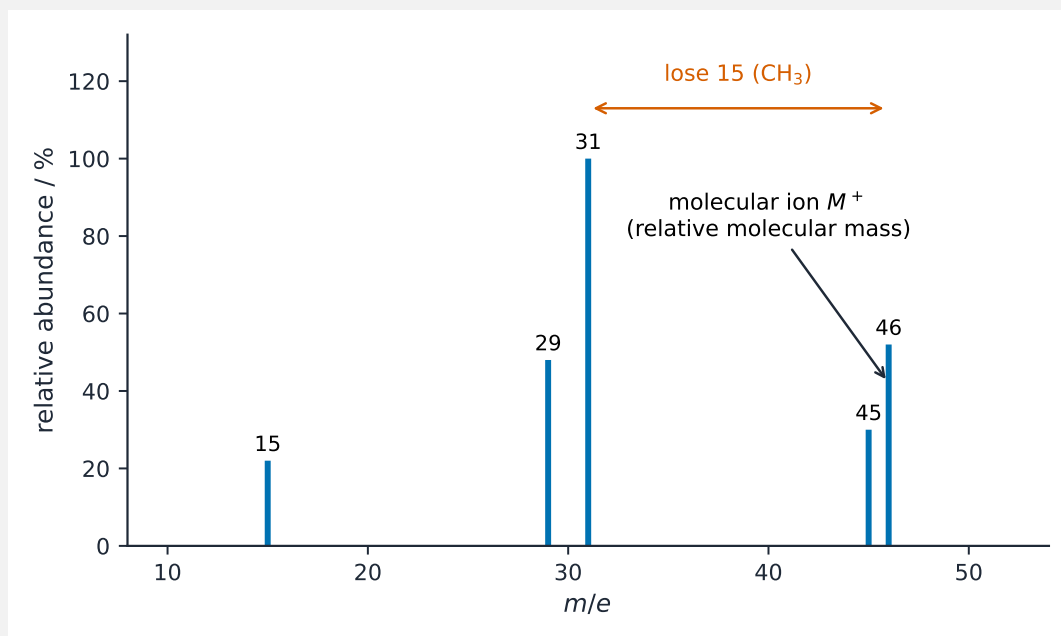
Build the skills to answer exam questions on **isotopes** 同位素—what they are, the ${}^A_Z\text{X}$ notation, their properties, and calculating **relative atomic mass** 相对原子质量 from isotopic abundances.

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



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 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 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
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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]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **1.2 Isotopes** past-paper sheet in the Library, or try these in **Practice mode**:

- 9701/21 N25 —Q1 (isotopes and masses, calculation)
- 9701/22 N25 —Q1 (atomic structure, structured)

Solutions

2.1 atoms of the same element (same number of protons) with different numbers of neutrons.

2.2 protons 17; neutrons $37 - 17 = 20$; electrons 17.

3.1 B. Isotopes have the same number of protons.

3.2 B. The same electron arrangement gives the same chemistry.

3.3 (a) $A_r = \frac{(10 \times 20) + (11 \times 80)}{100} = \frac{1080}{100} = 10.8$.

(b) ^{11}B has one more neutron, so more mass in the same volume.

3.4 $A_r = \frac{(63 \times 69) + (65 \times 31)}{100} = \frac{6362}{100} = 63.6$.