

Exercise walk-through

Isotopes ■ 1.2

eXercise

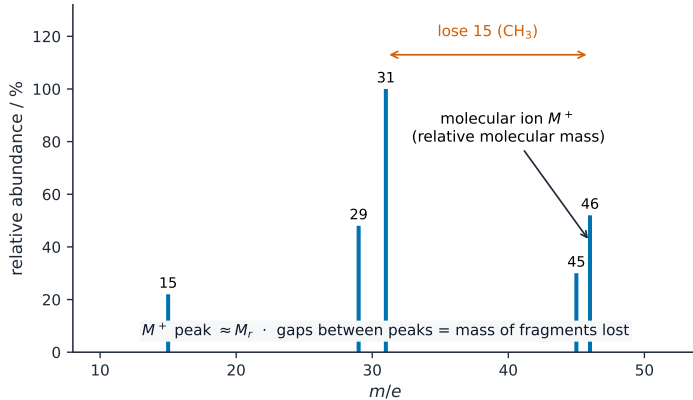
You must be able to

- 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

Method — What isotopes are

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 ${}_{17}^{35}\text{Cl}$ and ${}_{17}^{37}\text{Cl}$.

Method — What isotopes are



A mass spectrum reveals isotopes and their abundance

Method — 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.

Method — 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 :

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

Practice 2.1 ■ 2 marks

Define the term **isotope**.

Solution 2.1

Worked steps

atoms of the same element (same number of protons) **B1** with different numbers of neutrons **B1**.

Practice 2.2 ■ 3 marks

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

Solution 2.2

Method: What isotopes are

Worked steps

protons 17; neutrons $37 - 17 = 20$; electrons 17 **B1** *each*.

Exam-style 3.1 ■ 1 mark

Two isotopes of the same element always have the same:

A number of neutrons

B number of protons

C nucleon number

D density

Solution 3.1

Method: What isotopes are

A number of neutrons

B number of protons 

C nucleon number

D density

Worked steps

B. Isotopes have the same number of protons.

Exam-style 3.2 ■ 1 mark

Why do isotopes of an element have identical chemical properties?

- 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

Solution 3.2

Method: Same chemical, different physical properties

- 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

Worked steps

B. The same electron arrangement gives the same chemistry.

Exam-style 3.3 ■ 2 marks

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

- (a) Calculate the relative atomic mass of boron.
- (b) Explain why ^{11}B is denser than ^{10}B .

Solution 3.3

Method: Relative atomic mass from abundances

Worked steps

$$(a) A_r = \frac{(10 \times 20) + (11 \times 80)}{100} = \frac{1080}{100} = 10.8 \quad \text{M1 A1}.$$

(b) ^{11}B has one more neutron, so more mass in the same volume B1.

Exam-style 3.4 ■ 2 marks

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

Solution 3.4

Method: Relative atomic mass from abundances

Worked steps

$$A_r = \frac{(63 \times 69) + (65 \times 31)}{100} = \frac{6362}{100} = 63.6 \quad \text{M1 A1}.$$