

Exercise walk-through

Mass Spectra of Elements ■ 1.2

eXercise

You must be able to

- describe **isotopes** 同位素 as atoms of one element with different numbers of neutrons
- read a **mass spectrum** 质谱图 (peak position = mass, peak height = relative abundance)
- calculate the **average atomic mass** 平均原子质量 as an abundance-weighted average
- convert percentage abundances to fractions before averaging

Method — Isotopes

Isotopes share protons but differ in neutrons, so they differ in mass. Chlorine occurs as chlorine-35 and chlorine-37.

Method — Weighted average

Multiply each isotope mass by its fractional abundance and add:

$$\bar{m} = \sum (\text{fraction}) \times (\text{isotope mass}).$$

Chlorine (75% mass 35, 25% mass 37):

$$\bar{m} = 0.75(35) + 0.25(37) = 35.5 \text{ u.}$$

Method — The average is pulled toward the common isotope

The more abundant isotope pulls the average toward its own mass.

Practice 2.1 ■ 1 mark

State how two isotopes of the same element differ.

Solution 2.1

Method: Isotopes

Worked steps

In the number of neutrons (same protons, different mass) **B1**.

Practice 2.2 ■ 2 marks

An element is 60% mass 10 and 40% mass 11. Find its average atomic mass.

Solution 2.2

Worked steps

$$0.60(10) + 0.40(11) = 10.4 \text{ u} \quad \text{M1} \quad \text{A1}.$$

Practice 2.3 ■ 1 mark

On a mass spectrum, what does the height of a peak show?

Solution 2.3

Worked steps

Its relative abundance **B1**.

Practice 2.4 ■ 2 marks

Two isotopes of mass 20 and 22 are each 50% abundant. Find the average mass.

Solution 2.4

Method: The average is pulled toward the common isotope

Worked steps

$$0.5(20) + 0.5(22) = 21 \text{ u} \quad \text{M1} \quad \text{A1}.$$

Exam-style 3.1 ■ 1 mark

Isotopes of an element have the same number of

A neutrons

B protons

C total particles

D nothing

Solution 3.1

A neutrons

B protons 

C total particles

D nothing

Worked steps

B — the same number of protons.

Exam-style 3.2 ■ 1 mark

An element is 90% mass 20 and 10% mass 22. Its average atomic mass is closest to

A 20.0

B 20.2

C 21.0

D 22.0

Solution 3.2

A 20.0

B 20.2



C 21.0

D 22.0

Worked steps

$$\mathbf{B} \text{ — } 0.90(20) + 0.10(22) = 20.2.$$

Exam-style 3.3 ■ 2 marks

Boron has two isotopes: boron-10 (20%) and boron-11 (80%).

- (a) Find the average atomic mass.
- (b) State which isotope the average lies closer to, and why.

Solution 3.3

Worked steps

(a) $0.20(10) + 0.80(11) = 10.8$ u **M1** **A1**. (b) Closer to boron-11, since it is more abundant **B1**.

Exam-style 3.4 ■ 2 marks

A mass spectrum of an element shows two peaks: mass 63 (69%) and mass 65 (31%).

- (a) Find the average atomic mass.
- (b) Identify the element (hint: this is its relative atomic mass).

Solution 3.4

Worked steps

(a) $0.69(63) + 0.31(65) = 63.6$ u **M1** **A1**. (b) Copper (Cu) **B1**.