

# 1.2 Mass Spectra of Elements

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Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

**Total: 14 marks**

## Objective

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Build the skills to answer exam questions on **mass spectra of elements**.

**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

## 1 Worked examples

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Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

### ■ Isotopes

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

### ■ 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):

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

### ■ The average is pulled toward the common isotope

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

## 2 Practice

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Now apply the methods above.

**2.1** State how two isotopes of the same element differ. [1]

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**2.2** An element is 60% mass 10 and 40% mass 11. Find its average atomic mass. [2]

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**2.3** On a mass spectrum, what does the height of a peak show? [1]

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**2.4** Two isotopes of mass 20 and 22 are each 50% abundant. Find the average mass. [2]

### 3 Exam-style questions

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**3.1** Isotopes of an element have the same number of [1]

- **A** neutrons
- **B** protons
- **C** total particles
- **D** nothing

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**3.2** An element is 90% mass 20 and 10% mass 22. Its average atomic mass is closest to [1]

- **A** 20.0
- **B** 20.2
- **C** 21.0
- **D** 22.0

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

(a) Find the average atomic mass. [2]

(b) State which isotope the average lies closer to, and why. [1]

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

(a) Find the average atomic mass. [2]

(b) Identify the element (hint: this is its relative atomic mass). [1]

## 4 Go further

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You are ready for more on this subtopic:

- work through the interactive **1.2 Mass Spectra of Elements** lesson on the **Learn** page;
- read the **Atomic Structure and Properties** section of the AP Chemistry handout on the **Know** page for the full explanation and worked diagrams.

## Solutions

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

**2.2**  $0.60(10) + 0.40(11) = 10.4$  u.

**2.3** Its relative abundance.

**2.4**  $0.5(20) + 0.5(22) = 21$  u.

**3.1 B** —the same number of protons.

**3.2 B** — $0.90(20) + 0.10(22) = 20.2$ .

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

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