

1.2 Mass Spectra of Elements

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

KEY WORDS mass spectrum 质谱图 • isotope 同位素 • relative abundance 相对丰度
• average atomic mass 平均原子质量

Objective

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

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

Now apply the methods above.

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

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

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

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

3 Exam-style questions

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

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

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

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]

Solutions

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).