

1.6 Photoelectron Spectroscopy

Name: _____ Class: _____ Date: _____

Total: 12 marks

KEY WORDS binding energy 结合能 • photoelectron spectroscopy 光电子能谱 • electron configuration 电子排布
• nucleus 原子核

Objective

Build the skills to answer exam questions on **photoelectron spectroscopy (PES)**.

You must be able to:

- describe how **photoelectron spectroscopy** 光电子能谱 ejects electrons and measures their **binding energy** 结合能
- interpret a PES spectrum (one peak per subshell)
- read peak position (binding energy) and peak height (number of electrons)
- match a spectrum to an electron configuration

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.

■ One peak per subshell

Each peak corresponds to one subshell. Its position gives the binding energy; its height is proportional to the number of electrons in that subshell.

■ Higher binding energy is closer in

Electrons closer to the nucleus are held more tightly, so they have a higher binding energy. The 1s peak is always at the highest binding energy.

■ Reading a ratio

Neon's PES has peaks in the ratio 2 : 2 : 6, matching $1s^2 2s^2 2p^6$. A filled 2p peak is three times taller than a filled 2s.

2 Practice

Now apply the methods above.

2.1 State what the height of a PES peak is proportional to.

[1]

2.2 Which electrons have the highest binding energy — those closest to or farthest from the nucleus? [1]

2.3 Neon's PES shows peaks in the height ratio 2 : 2 : 6. Identify the subshells. [2]

2.4 How many times taller is a filled $2p$ peak than a filled $2s$ peak? [1]

3 Exam-style questions

3.1 In PES, a higher binding energy means the electron is [1]

- **A** farther from the nucleus
 - **B** closer to the nucleus
 - **C** more numerous
 - **D** at a lower energy shell that is easier to remove
-

3.2 A PES spectrum with three peaks of relative height 2 : 2 : 6 belongs to an atom with configuration [1]

- **A** $1s^2 2s^2 2p^6$
 - **B** $1s^2 2s^2 2p^4$
 - **C** $1s^2 2p^6 3s^2$
 - **D** $1s^6 2s^2 2p^2$
-

3.3 Sodium's PES has peaks in the ratio 2 : 2 : 6 : 1.

(a) Write the electron configuration this represents. [2]

(b) State which peak is at the highest binding energy. [1]

3.4 A PES spectrum has a small peak and a larger peak, with the small peak at a higher binding energy.

(a) State which peak is closer to the nucleus. [1]

(b) Explain what a taller peak tells you. [1]

Solutions

2.1 The number of electrons in that subshell.

2.2 Those closest to the nucleus.

2.3 $1s$, $2s$, and $2p$.

2.4 Three times ($2p$ holds 6, $2s$ holds 2).

3.1 B — a higher binding energy means closer to the nucleus.

3.2 A — $2 : 2 : 6$ matches $1s^2 2s^2 2p^6$.

3.3 (a) $1s^2 2s^2 2p^6 3s^1$. (b) The $1s$ peak.

3.4 (a) The small peak (higher binding energy). (b) It has more electrons in that subshell.