

Exercise walk-through

1.6

Photoelectron Spectroscopy

AP Chemistry

You must be able to

- describe how **photoelectron spectroscopy** ejects electrons and measures their **binding energy**
- 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

The method

Method — 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.

Exercises 2.1-2.3

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]

Exercises 2.1-2.3

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

[1]

2.1

- The number of electrons in that subshell

2.2 Which electrons have the highest binding energy – those closest to or farthest from the nucleus?

[1]

2.2

- Those closest to the nucleus

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

[2]

2.3

- $1s$, $2s$, and $2p$

Exercises 2.4-3.1

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

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

Exercises 2.4·3.1

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

2.4

- Three times ($2p$ holds 6, $2s$ holds 2)

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

3.1 B

- a higher binding energy means closer to the nucleus

Exercise 3.2

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 $1s^6 2s^2 2p^2$

Exercise 3.2

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 $1s^6 2s^2 2p^2$

3.2 A

- 2 : 2 : 6 matches $1s^2 2s^2 2p^6$

Exercise 3.3 (a)

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

(a) Write the electron configuration this represents.

[2]

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(a) Write the electron configuration this represents.

[2]

(a)

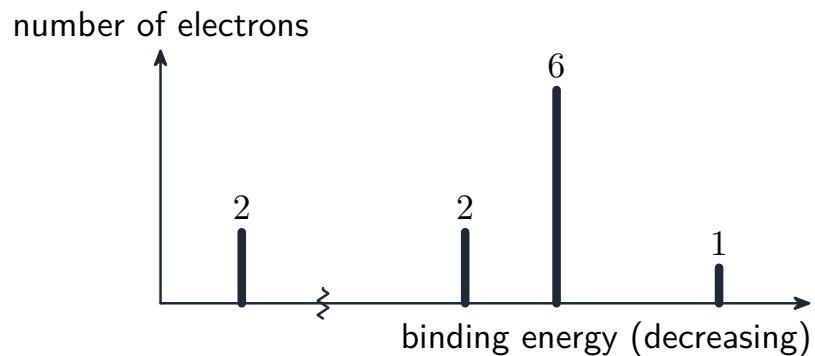
- $1s^2 2s^2 2p^6 3s^1$

Exercise 3.3 (b)

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

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

[1]

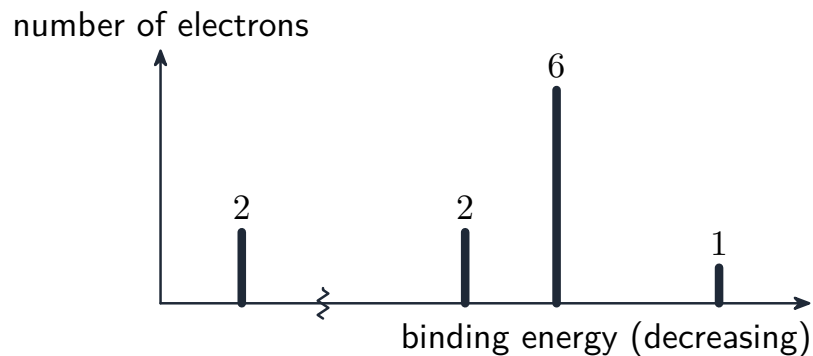


Exercise 3.3 (b)

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

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

[1]



(b)

- The 1s peak

Exercise 3.4 (a)

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]

Exercise 3.4 (a)

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]

(a)

- The small peak (higher binding energy)

Exercise 3.4 (b)

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

(b) Explain what a taller peak tells you.

[1]

Exercise 3.4 (b)

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

(b) Explain what a taller peak tells you.

[1]

(b)

- It has more electrons in that subshell