

N19 – Atomic Structure

and Periodicity

Photoelectron

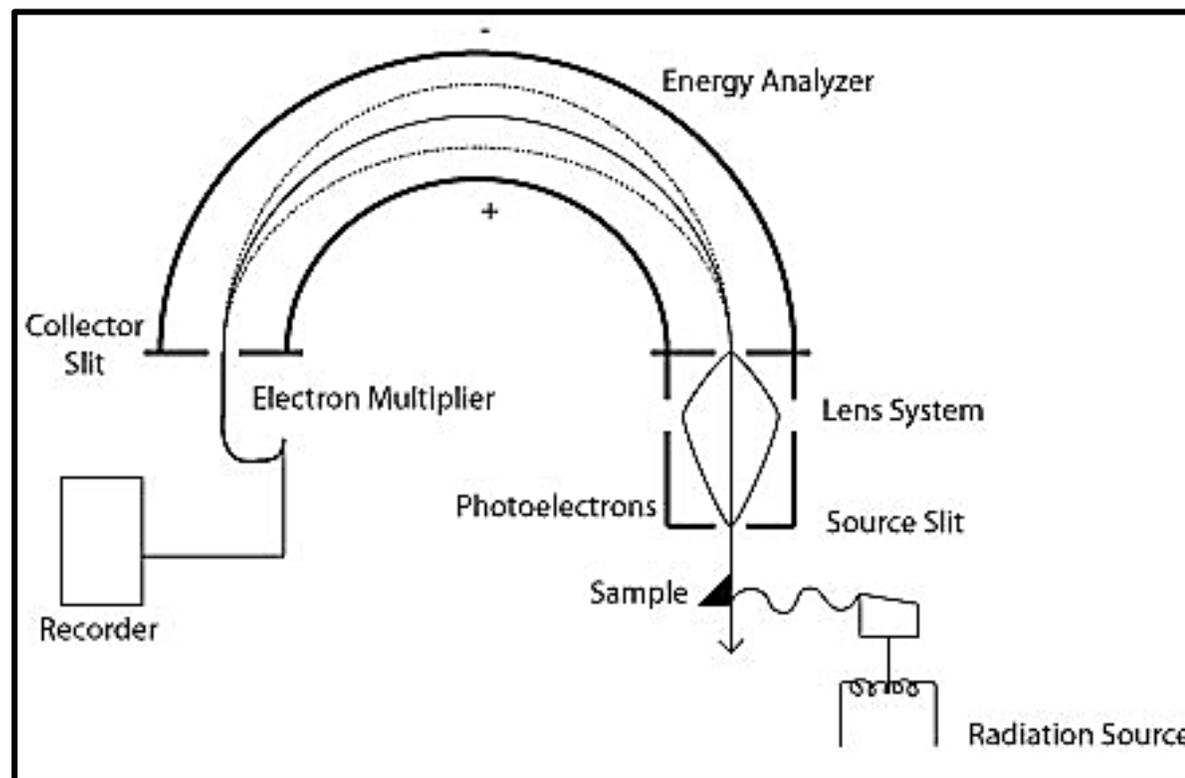
Spectroscopy

(PES)

Photoelectron Spectroscopy

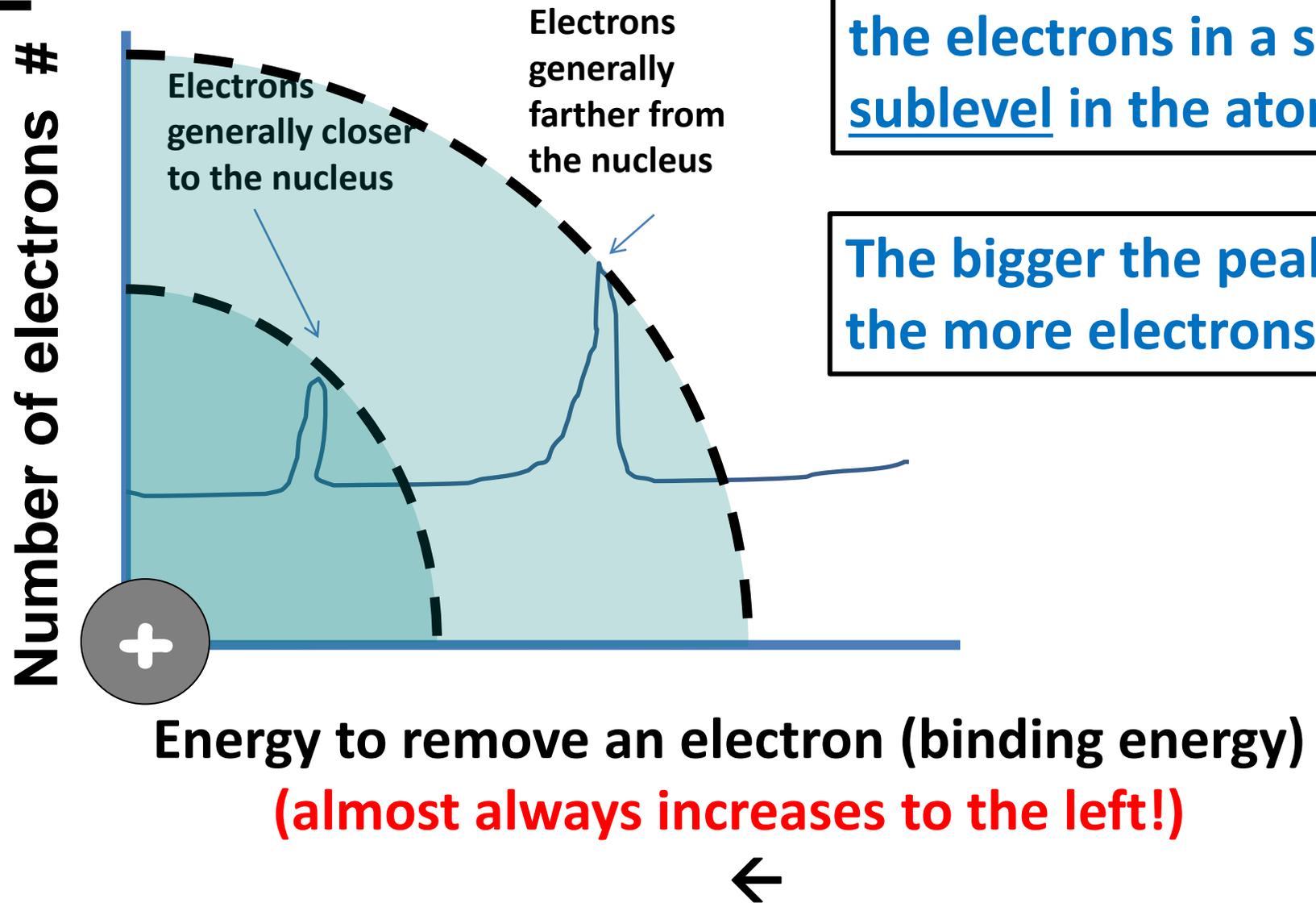
How it works

1. Sample is exposed to Electromagnetic Radiation (EMR)
2. Electrons jump out of sample and go through analyzer



PES Data

A graph!



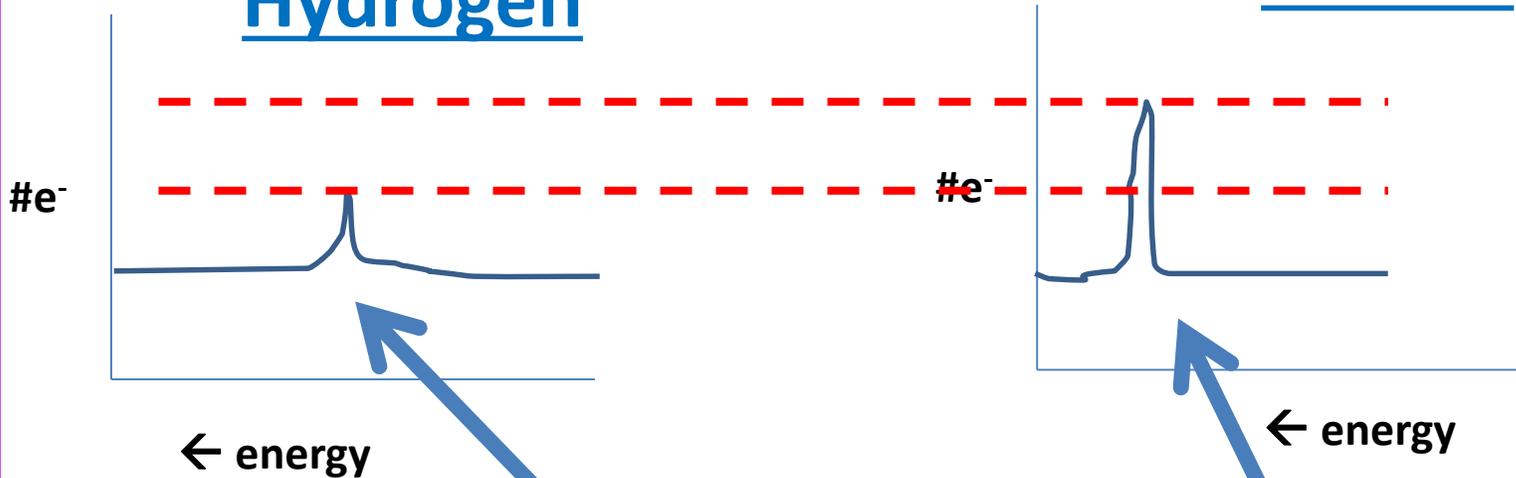
Each peak represents the electrons in a single sublevel in the atom

The bigger the peak – the more electrons

Hydrogen vs. Helium

Hydrogen

Helium



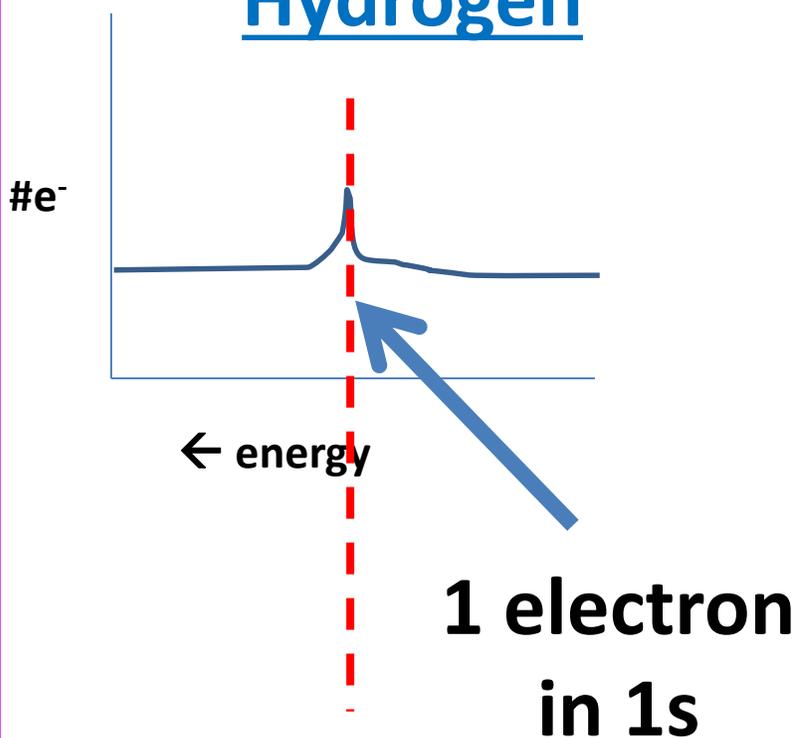
**1 electron
in 1s**

**2 electrons
in 1s**

The helium peak is twice as tall because there are twice as many electrons in Helium's 1s sublevel

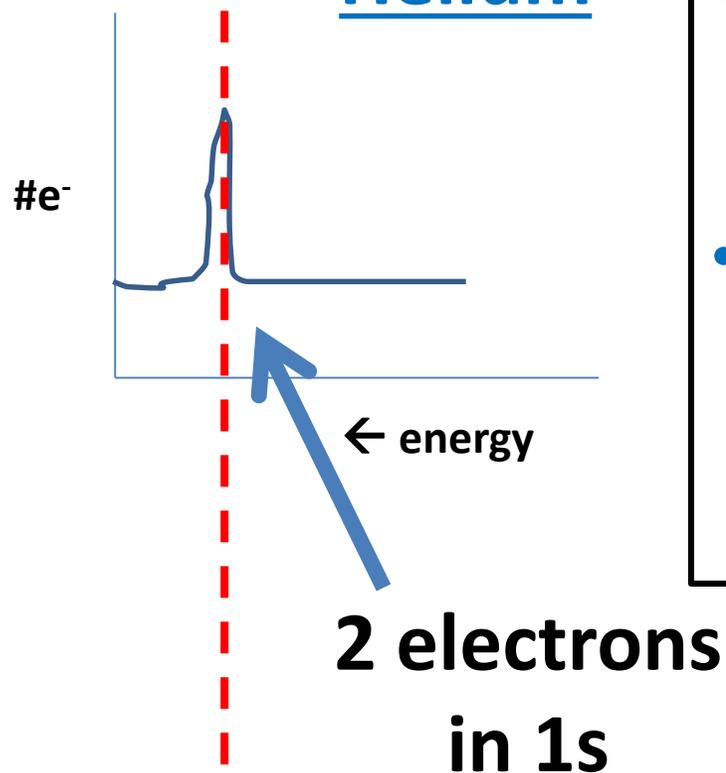
Hydrogen vs. Helium

Hydrogen



1 proton

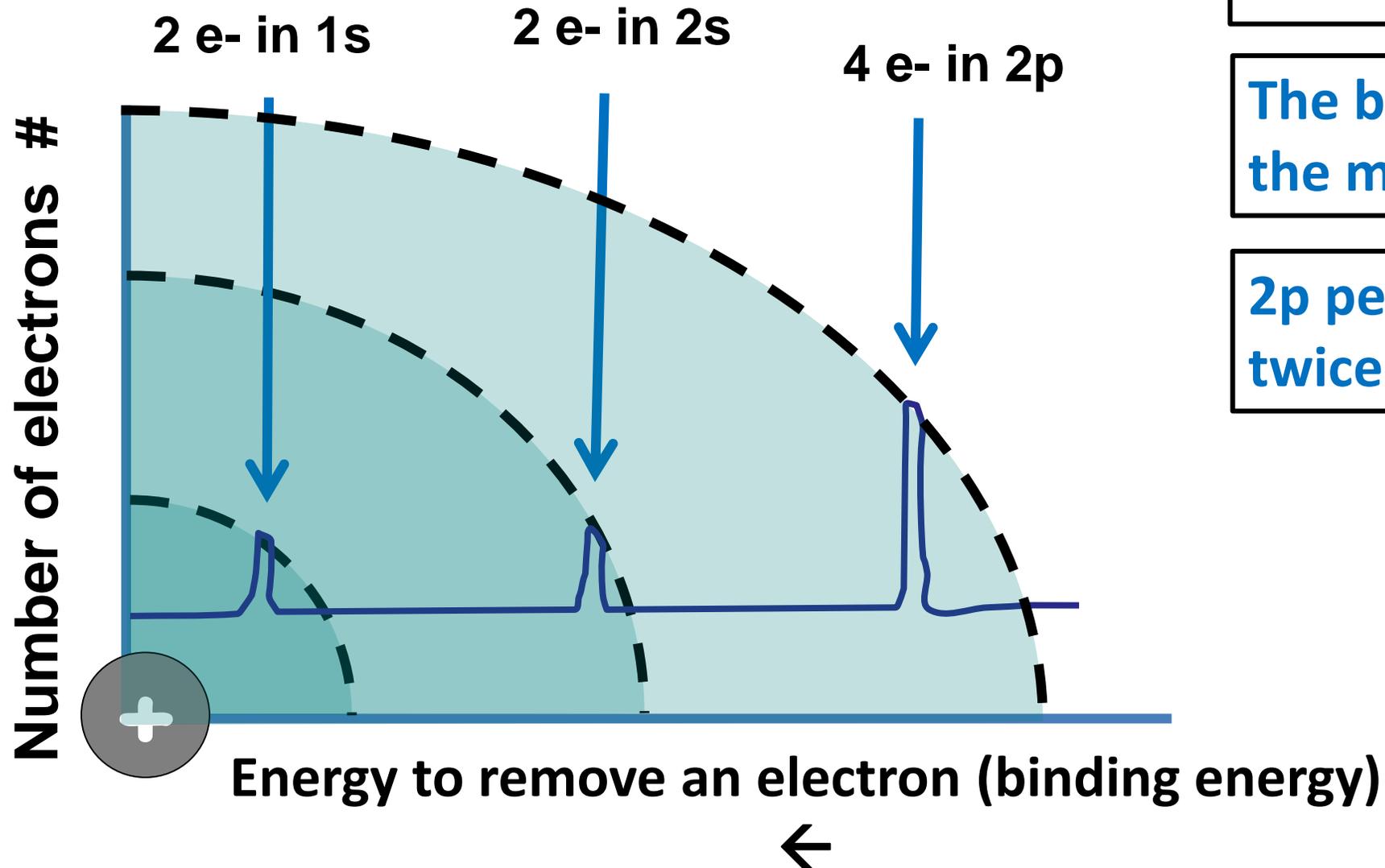
Helium



2 proton

- He peak is farther to the left (higher energy)
- More energy is needed to remove the 1s e in He.
- Held more tightly b/c there is a higher effective nuclear charge.

Oxygen – $1s^2 2s^2 2p^4$

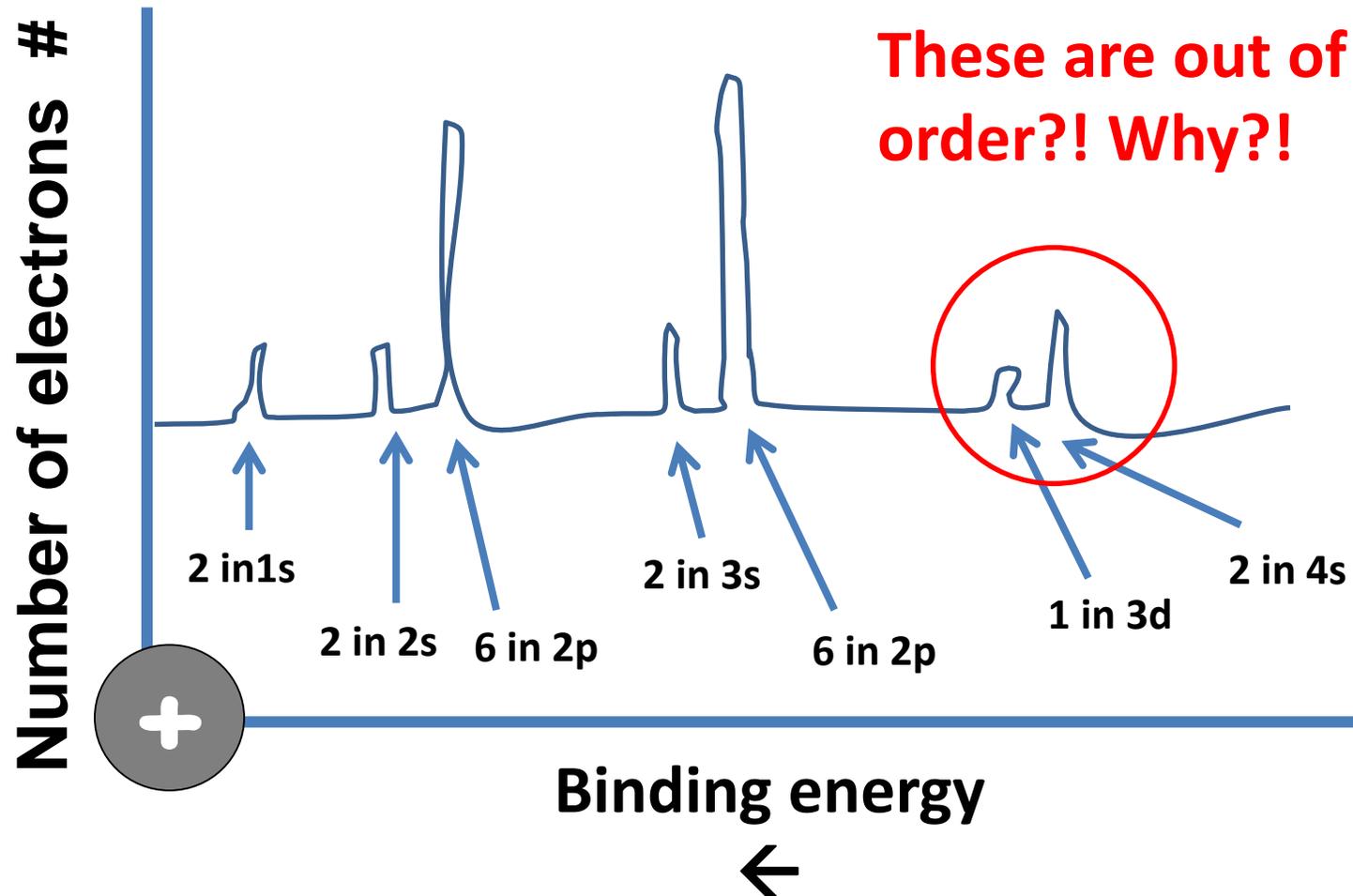


3 sublevels – 3 peaks
1s, 2s, 2p

The bigger the peak –
the more electrons

2p peak should be
twice as high as 1s peak

Scandium ($1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$)



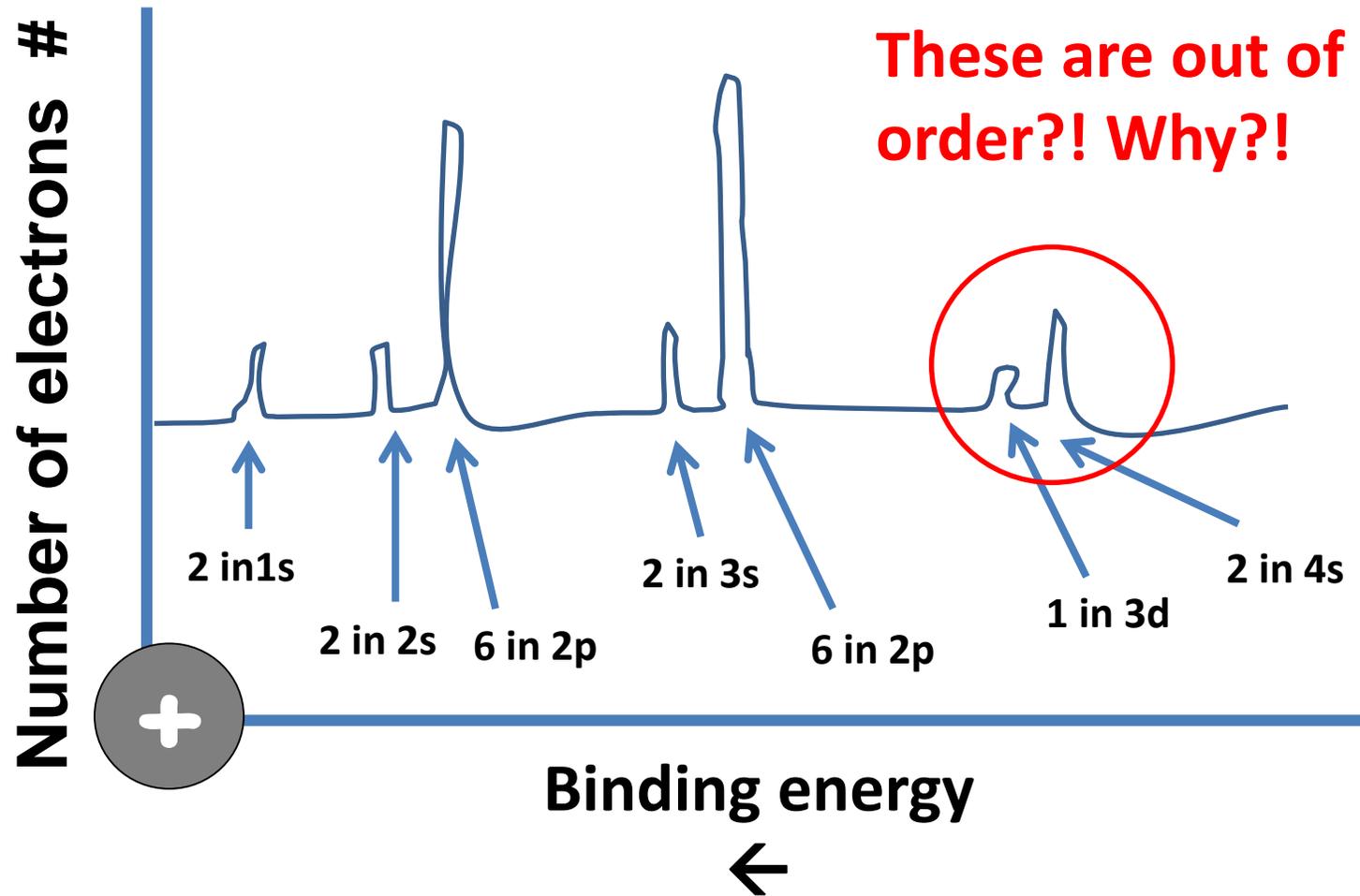
7 sublevels – 7 peaks
1s, 2s, 2p, 3s, 3p, 4s, 3d

2p and 3p peak should be biggest – 6 electrons

3d peak should be smallest – 1 electron

1st peak should be $1s^2$ – use that height to figure out the rest

Scandium ($1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$)



This is NOT a graph of what order things fill in!

This is a graph of the energy it takes to REMOVE electrons

3d shield 4s so it's easier (takes less energy) to remove 4s electrons compared to 3d electrons.

Example #1

Which element is this?

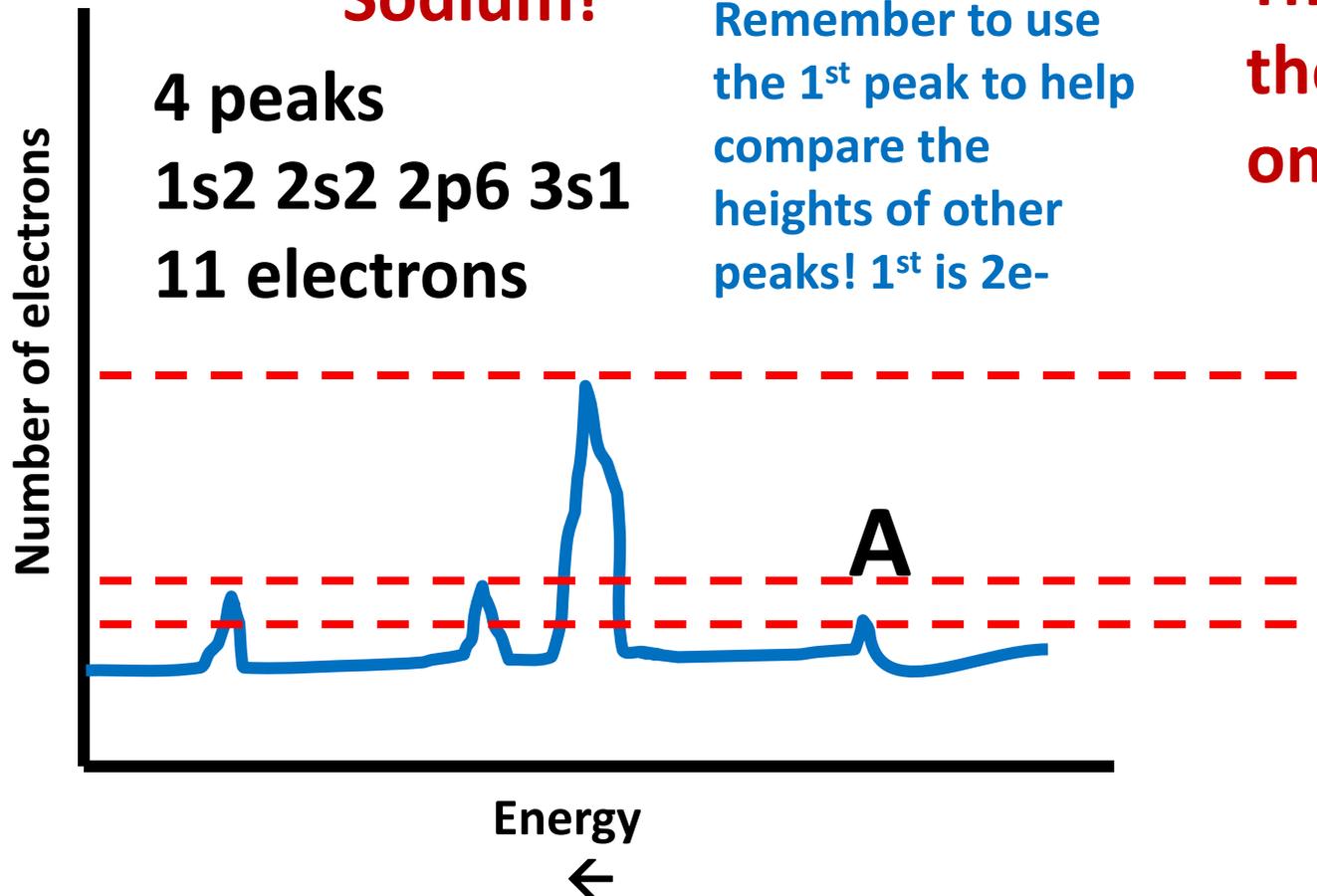
Sodium!

Remember to use the 1st peak to help compare the heights of other peaks! 1st is 2e-

4 peaks

1s² 2s² 2p⁶ 3s¹

11 electrons



Why is one peak much larger than the other?

This peak represents 6 electrons in the 2p sublevel. The other peaks only represent 1 or 2 electrons.

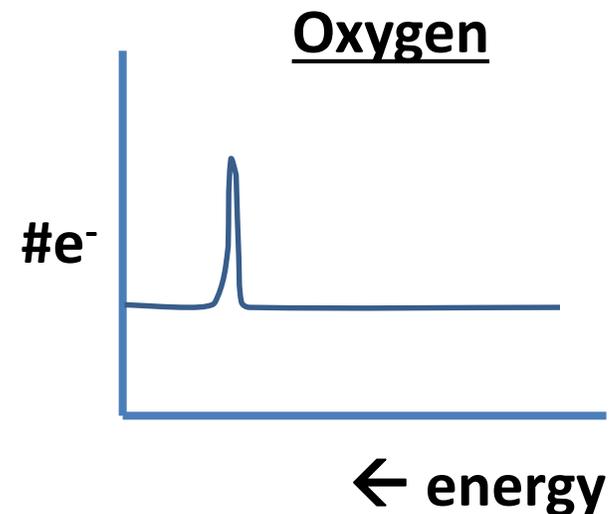
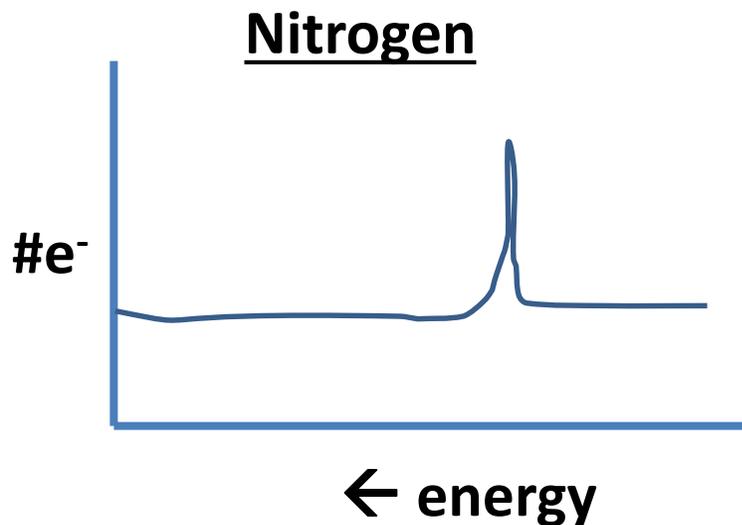
Which sublevel are the electrons at peak A in?

3s

Example #2

The PES data above shows only the peak for the 1s electrons.
Why is the peak for Nitrogen farther to the right?

It takes less energy to remove a 1s electron from Nitrogen because it has a larger radius than Oxygen (because it has a lower Effective nuclear charge (less protons) than oxygen) so there is less attraction between the nucleus and the electron in Nitrogen than in Oxygen.



Example #3

Draw the expected PES Spectrum for the element boron

1. Write configuration – $1s^2 2s^2 2p^1$
2. Figure out how many peaks – 3
3. Sketch $1s^2$ peak first – use that to figure out sizes of all other peaks

