N19 – Atomic Structure and Periodicity

Target: I can use Photoelectron Spectroscopy data to identify elements and explain the data based on atomic structure, nuclear attraction, and shielding.

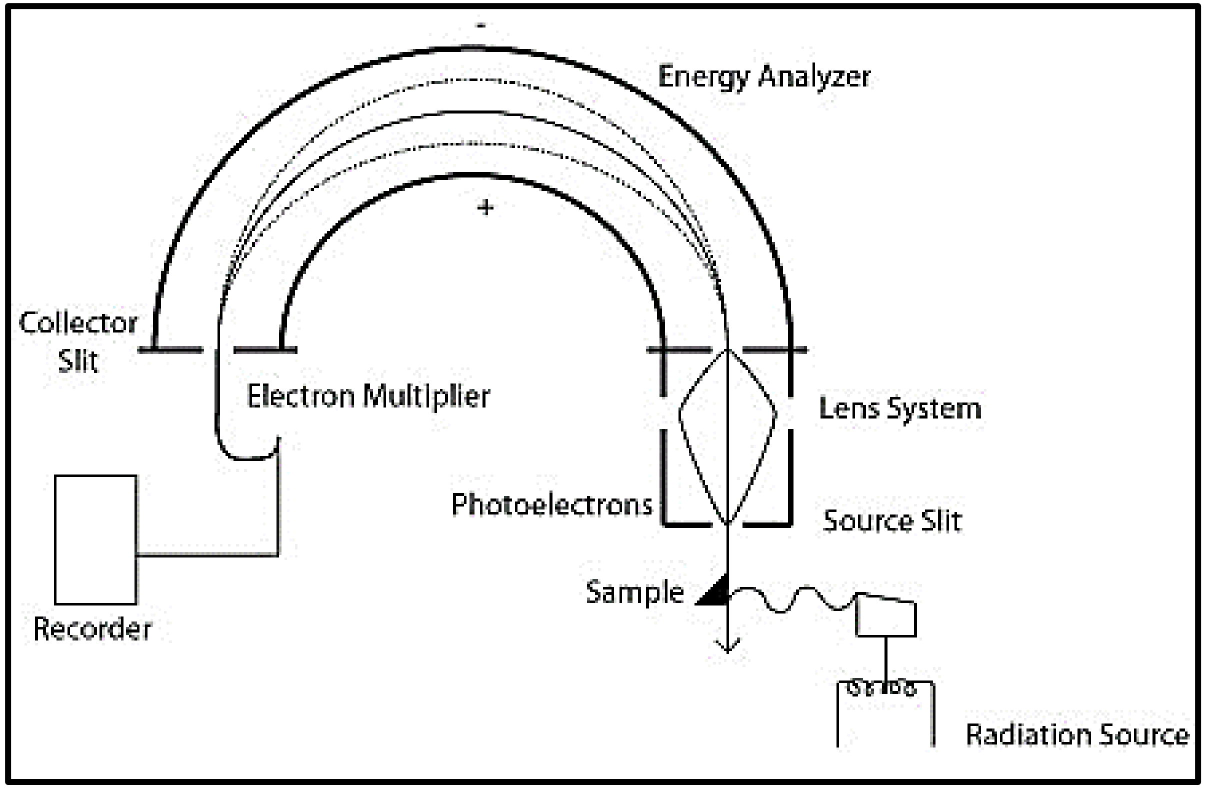
N19 – Atomic Structure and Periodicity

Photoelectron Spectroscopy (PES)

Photoelectron Spectroscopy

How it works

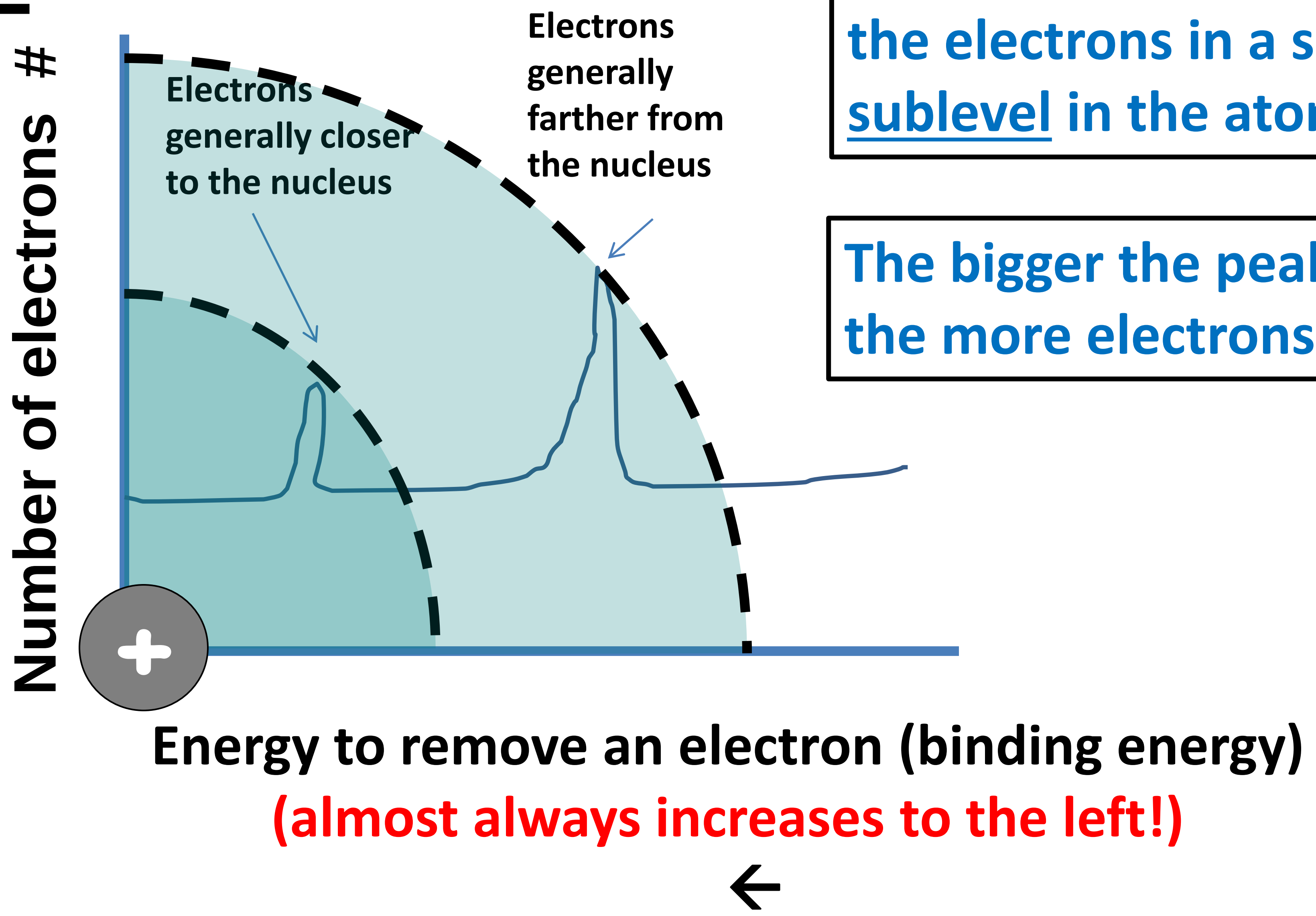
1. Sample is exposed to Electromagnetic Radiation (EMR)
2. Electrons jump out of sample and go through analyzer



http://chemwiki.ucdavis.edu

PES Data

A graph!

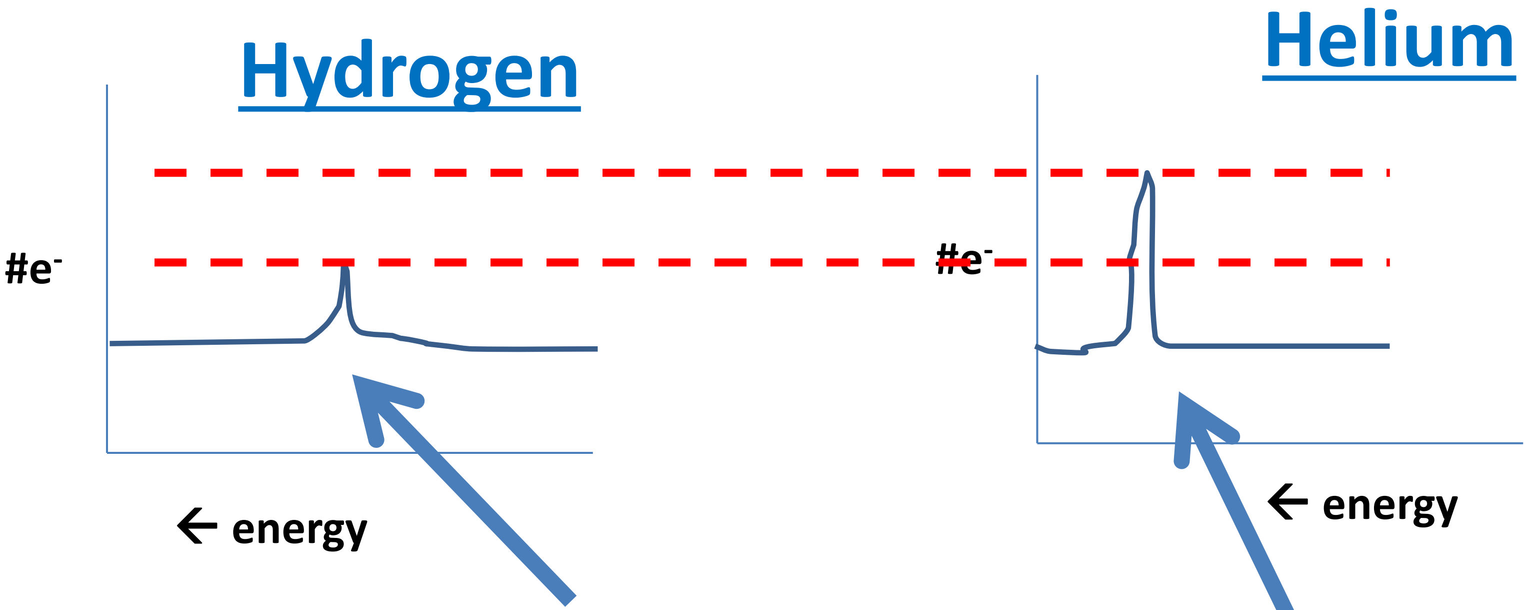


Each peak represents the electrons in a single sublevel in the atom

The bigger the peak – the more electrons

Hydrogen vs. Helium

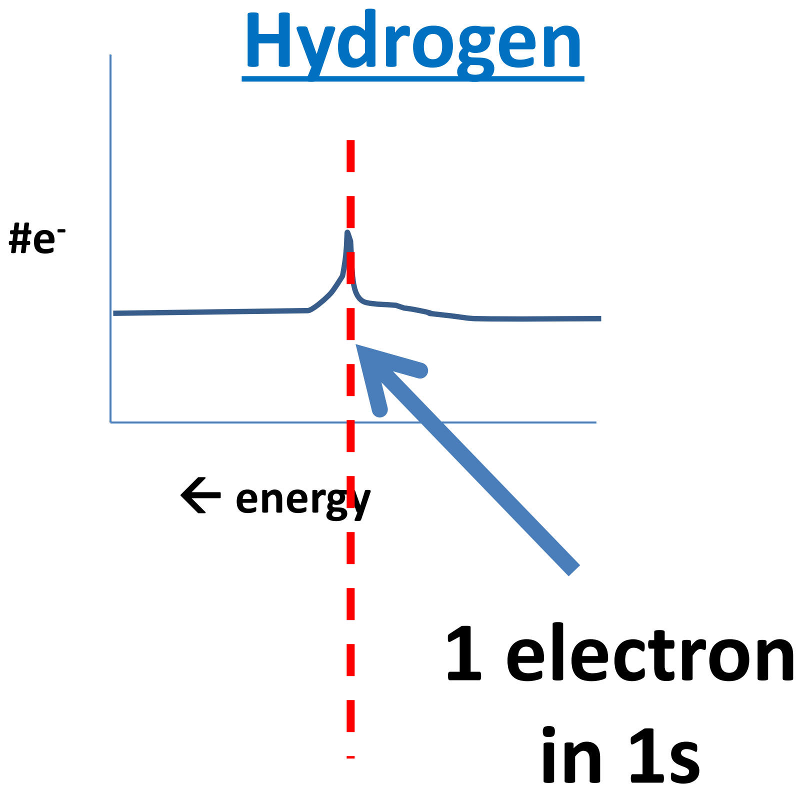
The helium peak is twice as tall because there are twice as many electrons in Helium's 1s sublevel



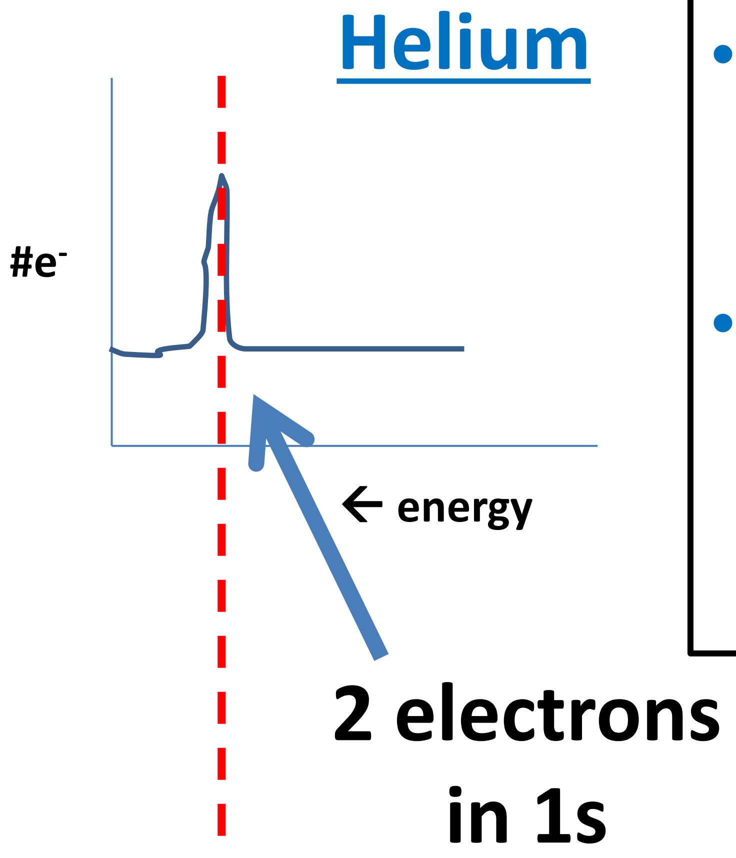
1 electron
in 1s

2 electrons
in 1s

Hydrogen vs. Helium



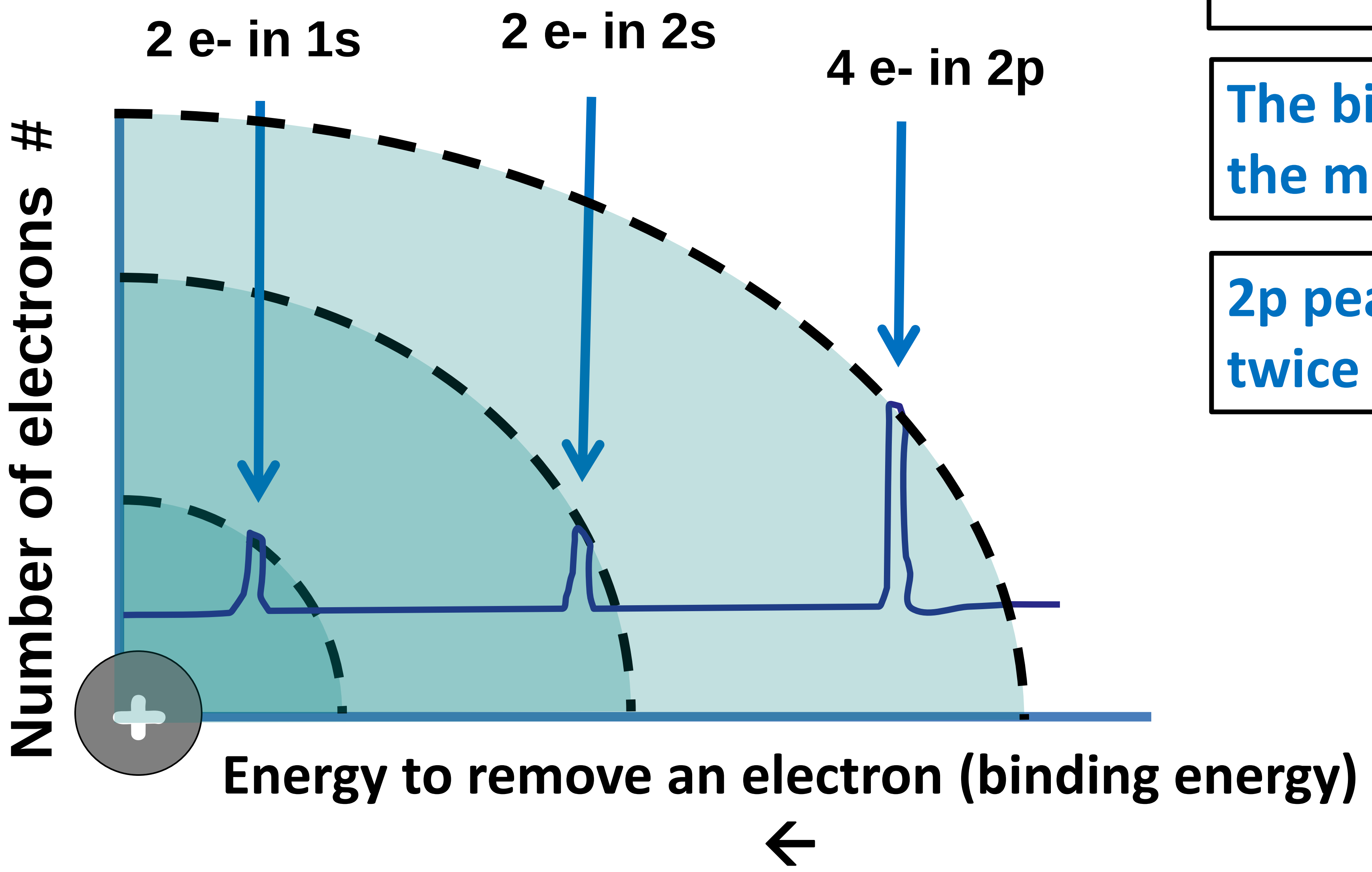
1 proton



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 – $1s^2 2s^2 2p^4$

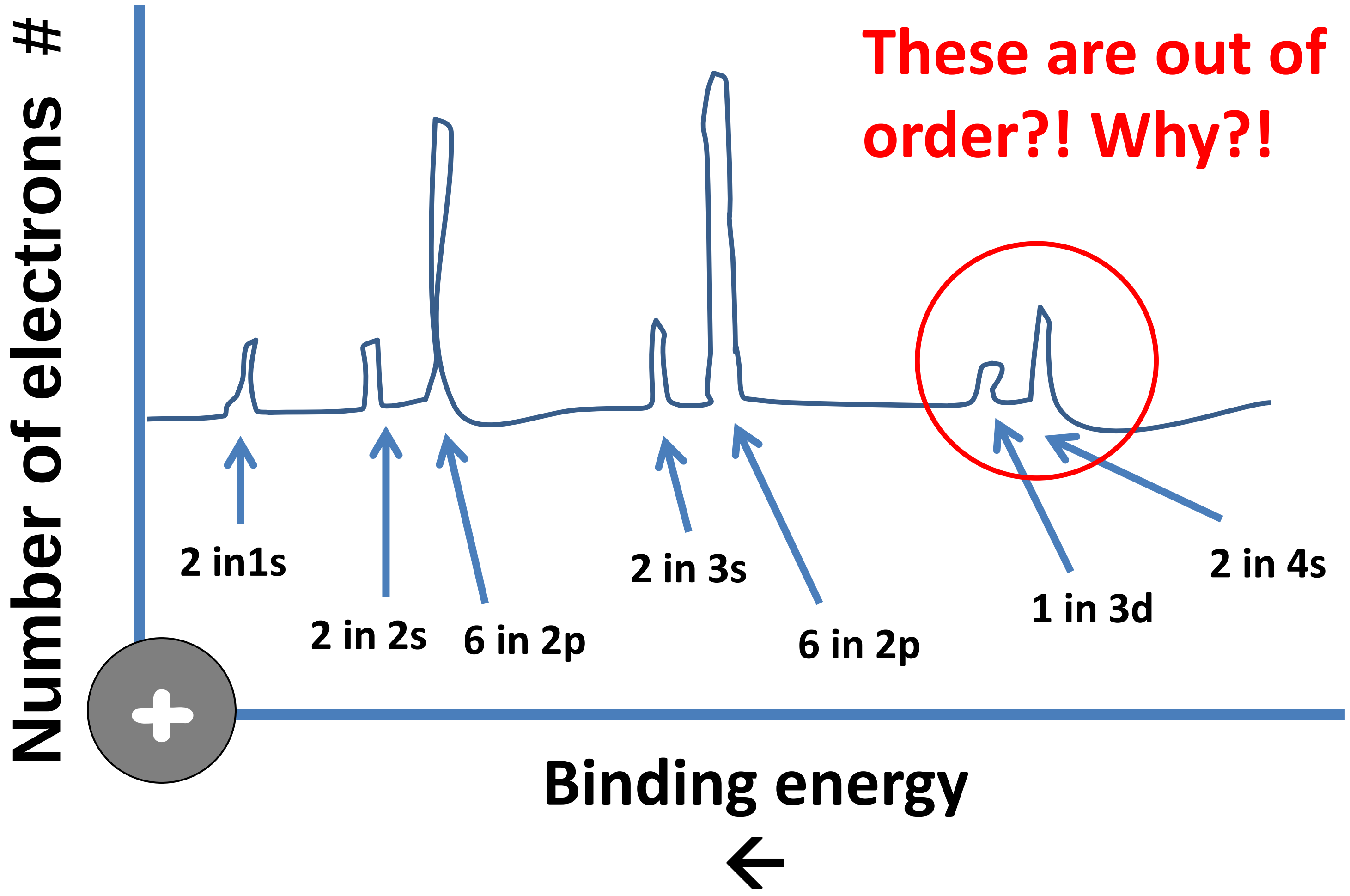


3 sublevels – 3 peaks
1s, 2s, 2p

The bigger the peak – the more electrons

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

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



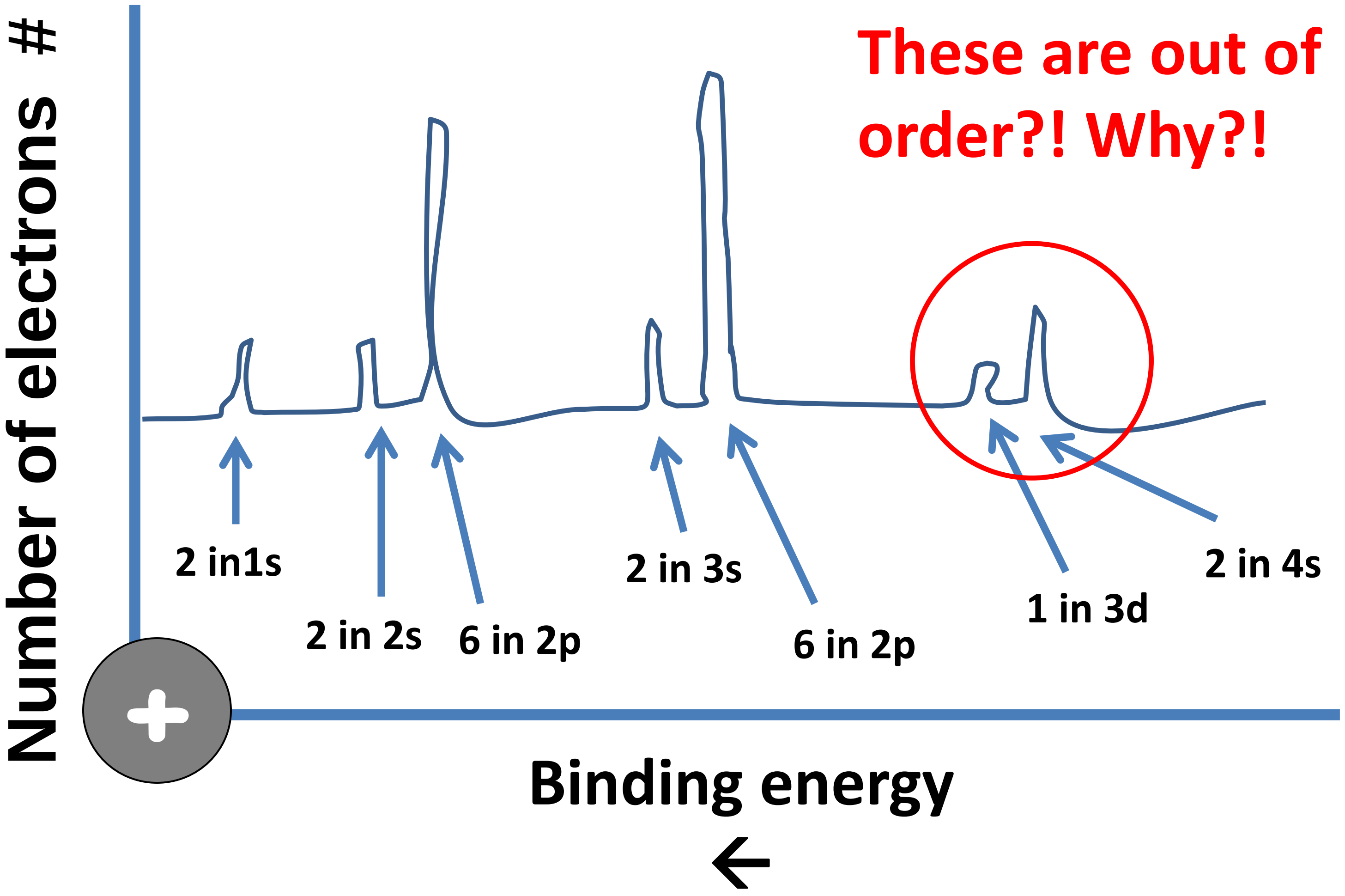
7 sublevels – 7 peaks
1s, 2s, 2p, 3s, 3p, 4s, 3d

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!

4 peaks

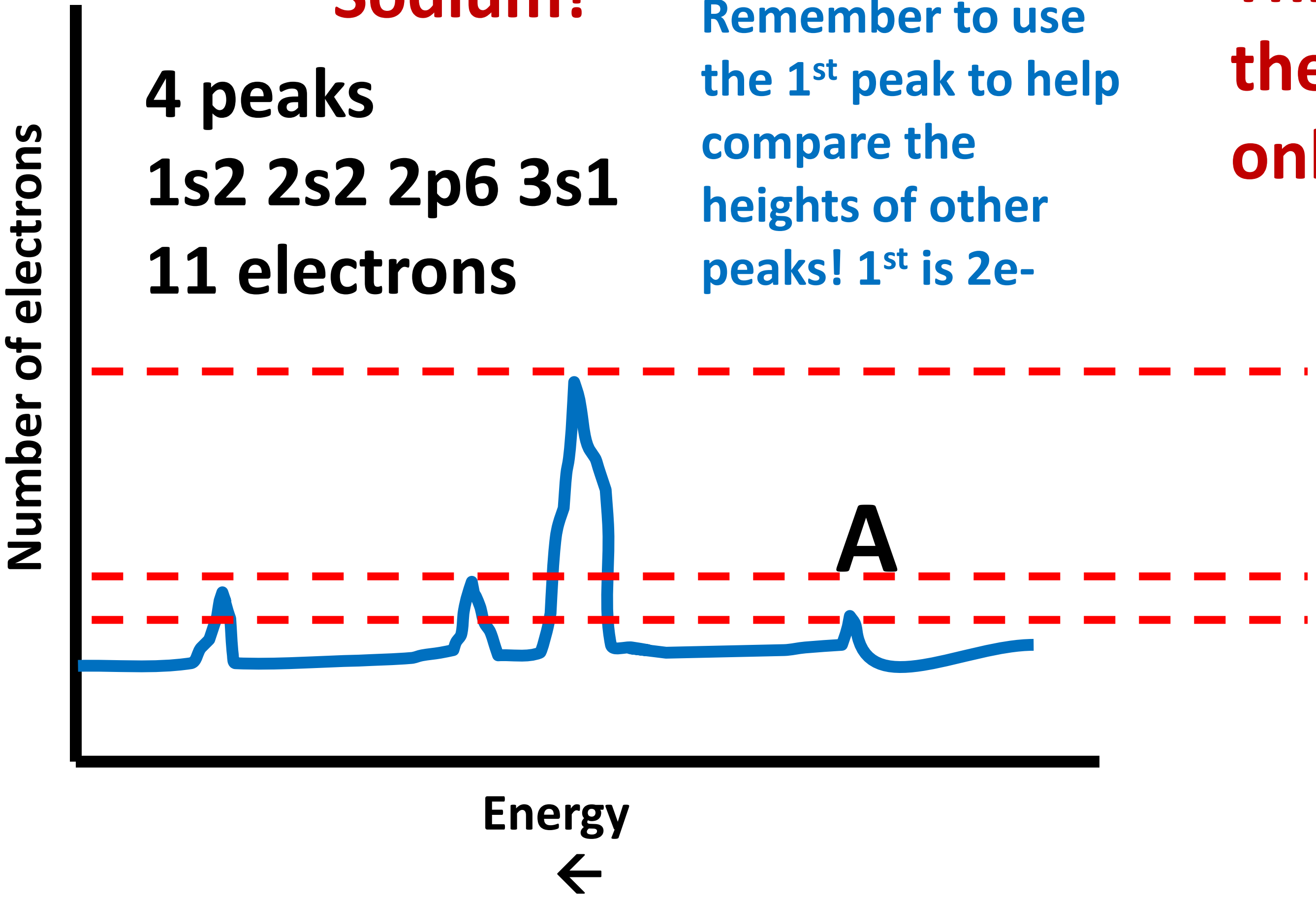
1s2 2s2 2p6 3s1

11 electrons

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

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.



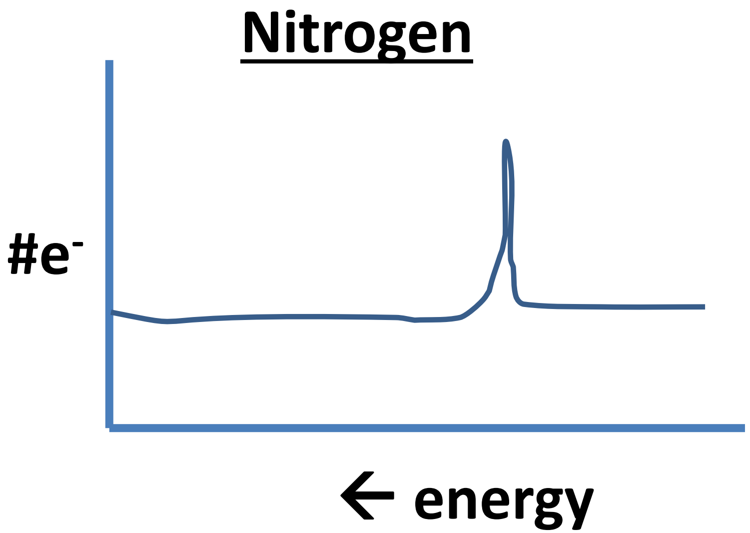
Which sublevel are the electrons at peak A in?

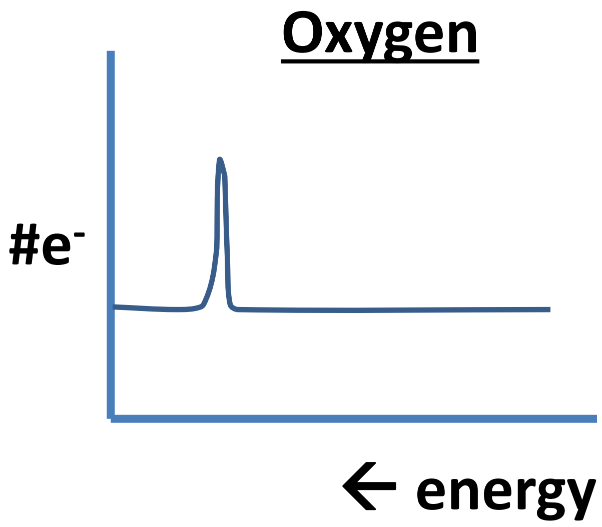
3s

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.

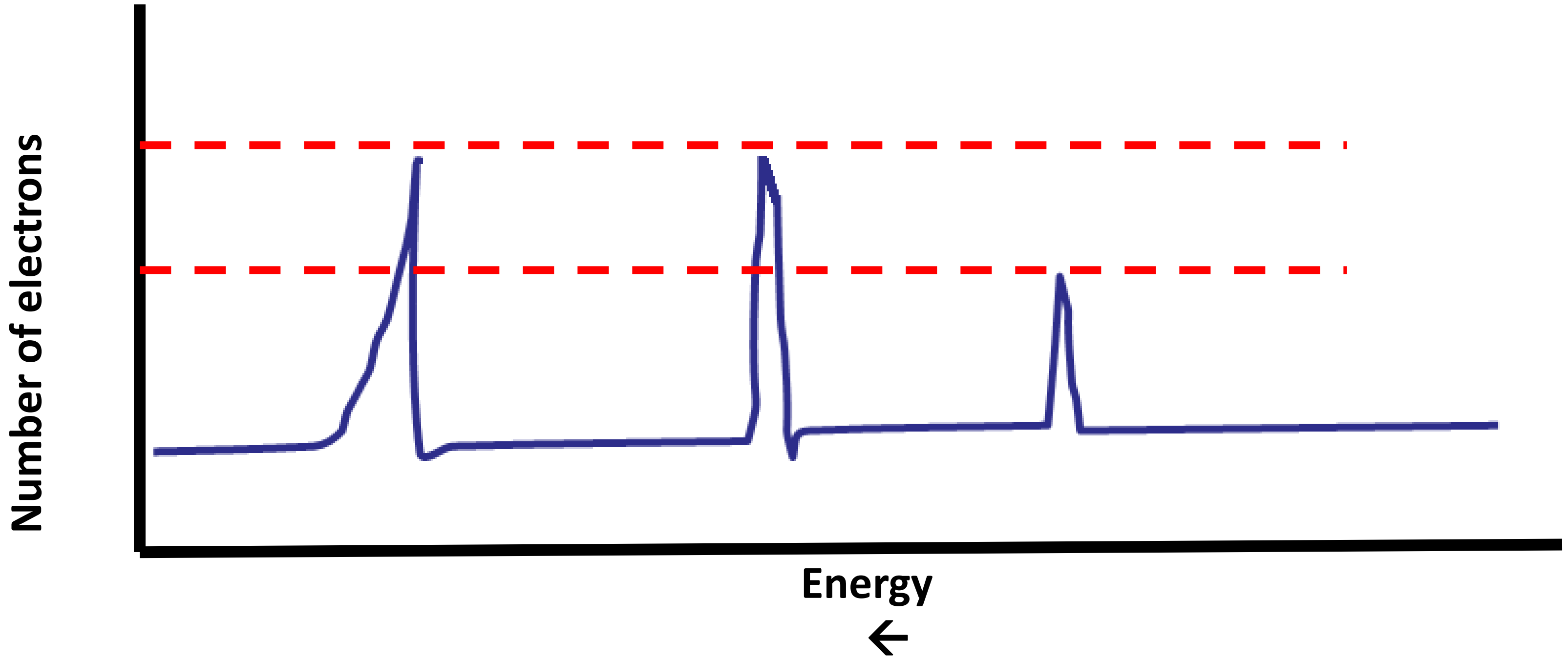




Example #3

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



Link to YouTube Presentation

https://youtu.be/tpfzOmlbKLk