Photoelectron Spectroscopy

(PES)

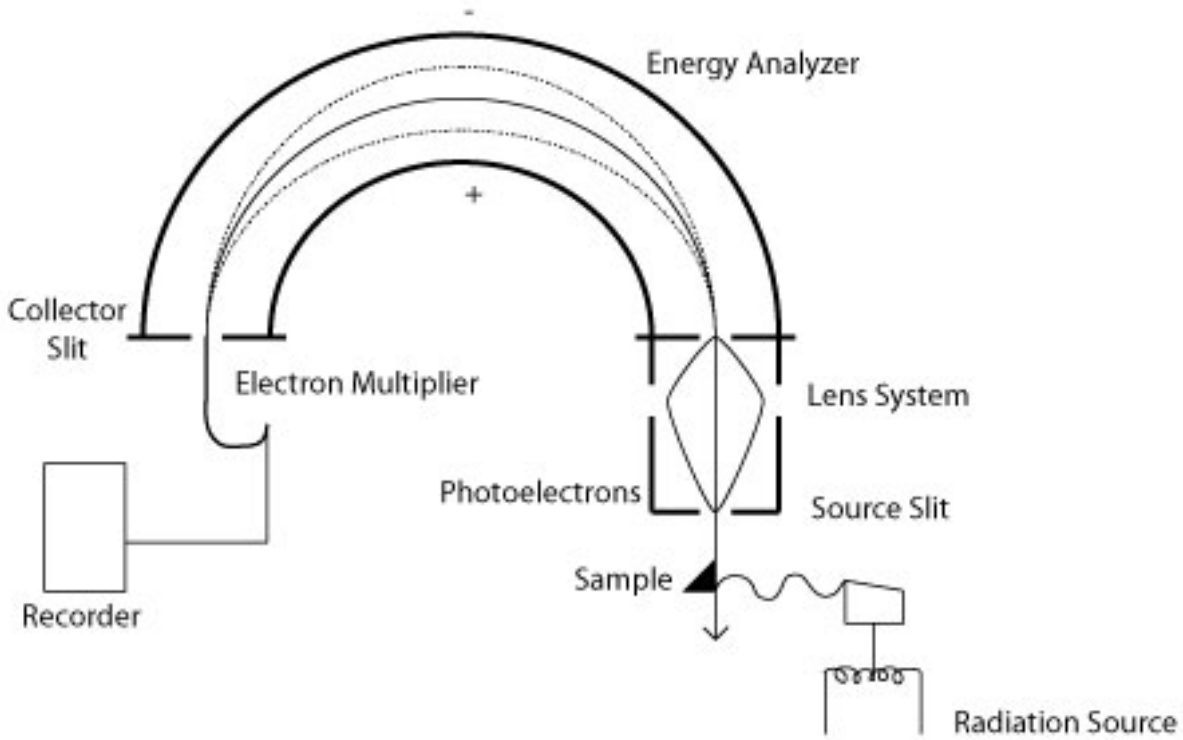
Spectroscopy

- Method of analyzing matter using electromagnetic radiation.

Photoelectron Spectroscopy

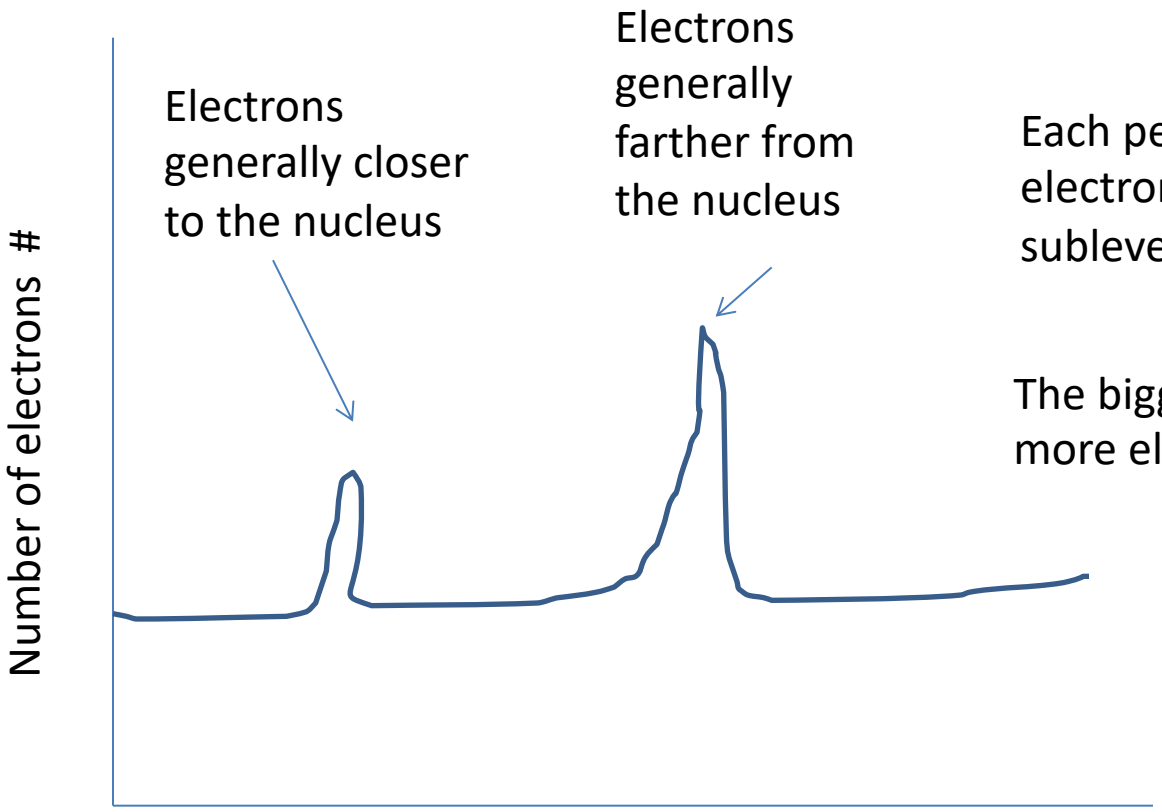
How it works:

1. Sample is exposed to EM radiation
2. Electrons jump out of sample and go through analyzer

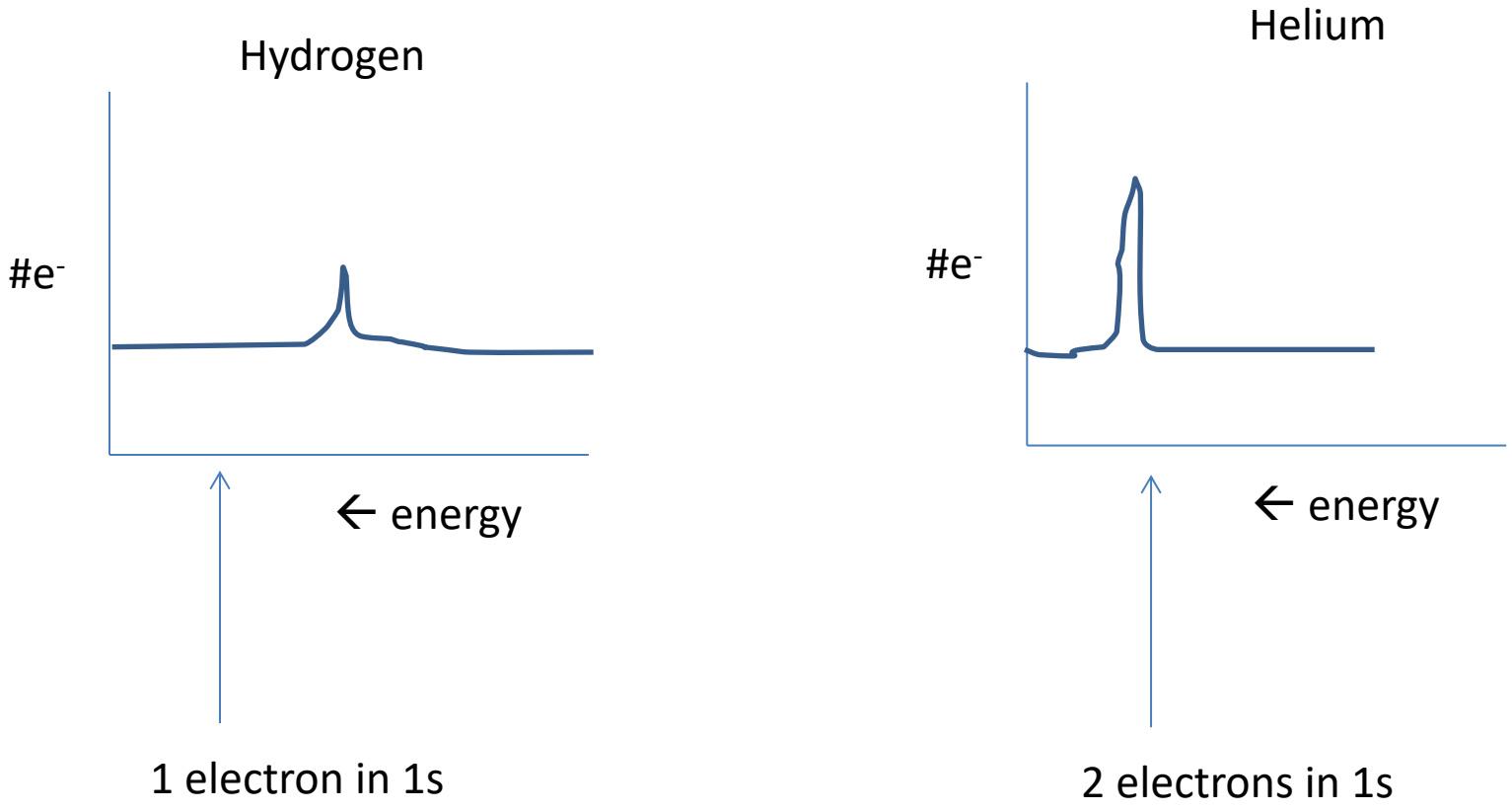


http://chemwiki.ucdavis.edu

PES Data

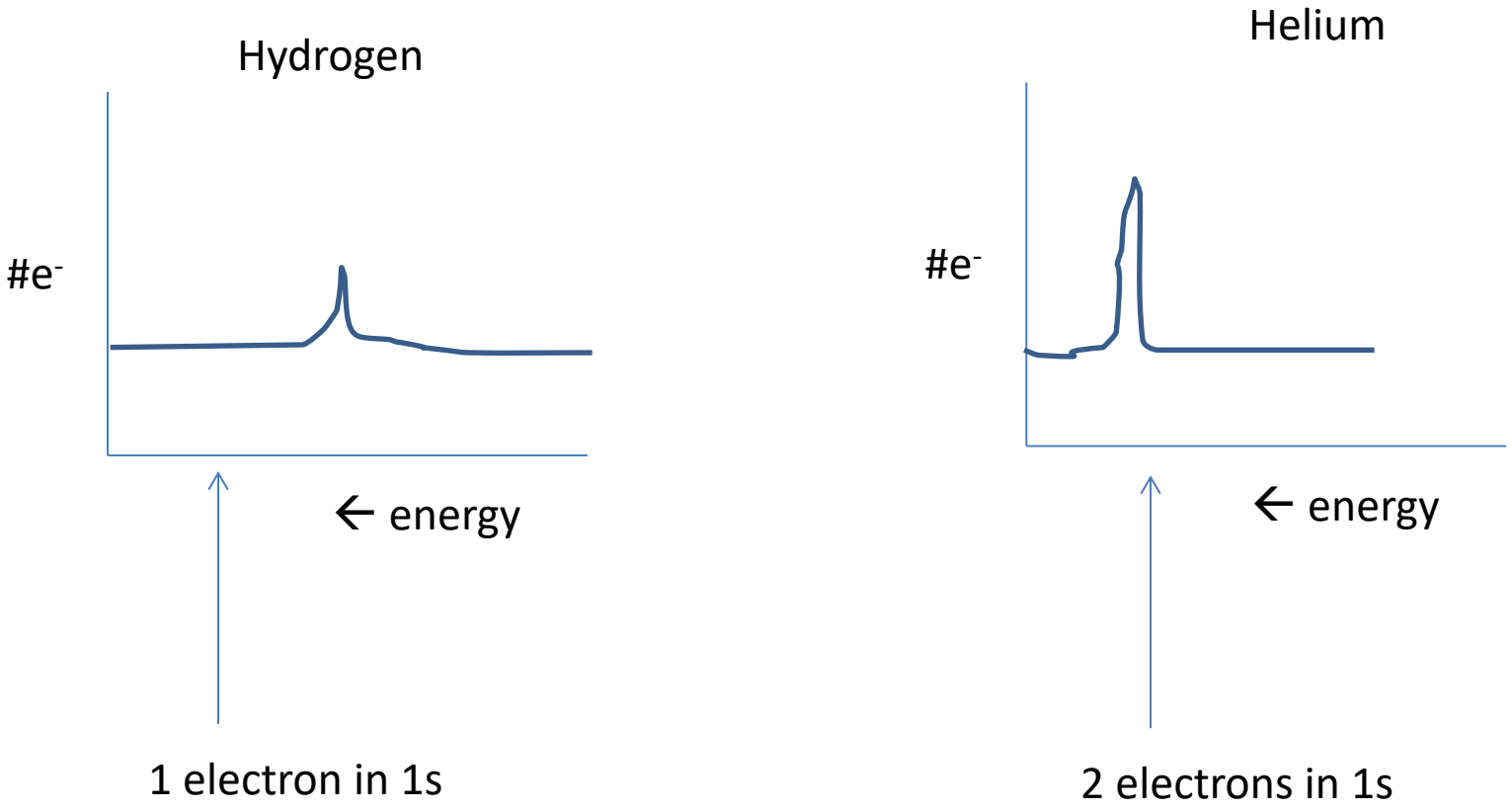

Electrons generally closer to the nucleus
Electrons generally farther from the nucleus
Each peak represents the electrons in a single sublevel in the atom
The bigger the peak – the more electrons
Number of electrons #
Energy to remove an electron
(binding energy)
(increases to the left!)
←

Hydrogen vs. Helium



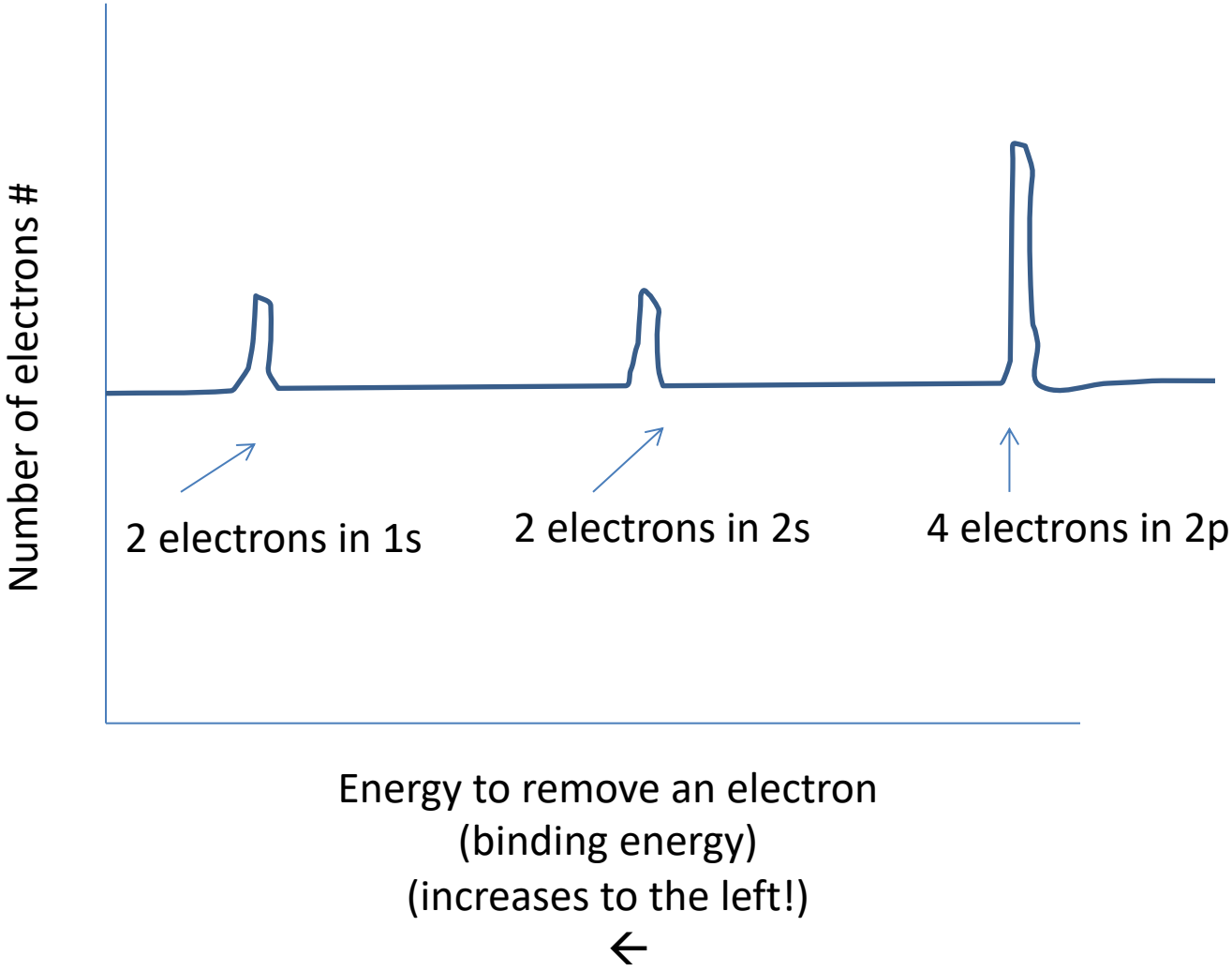
The helium peak is twice as tall because there are twice as many electrons in the 1s sublevel

Hydrogen vs. Helium



The helium peak is farther to the left (higher energy) thus more energy is needed to remove the 1s electrons in helium. They must be held more tightly because there is a higher effective nuclear charge. (Helium has 2 protons pulling on 1s but hydrogen only has 1)

Oxygen ($1s^2 2s^2 2p^4$)

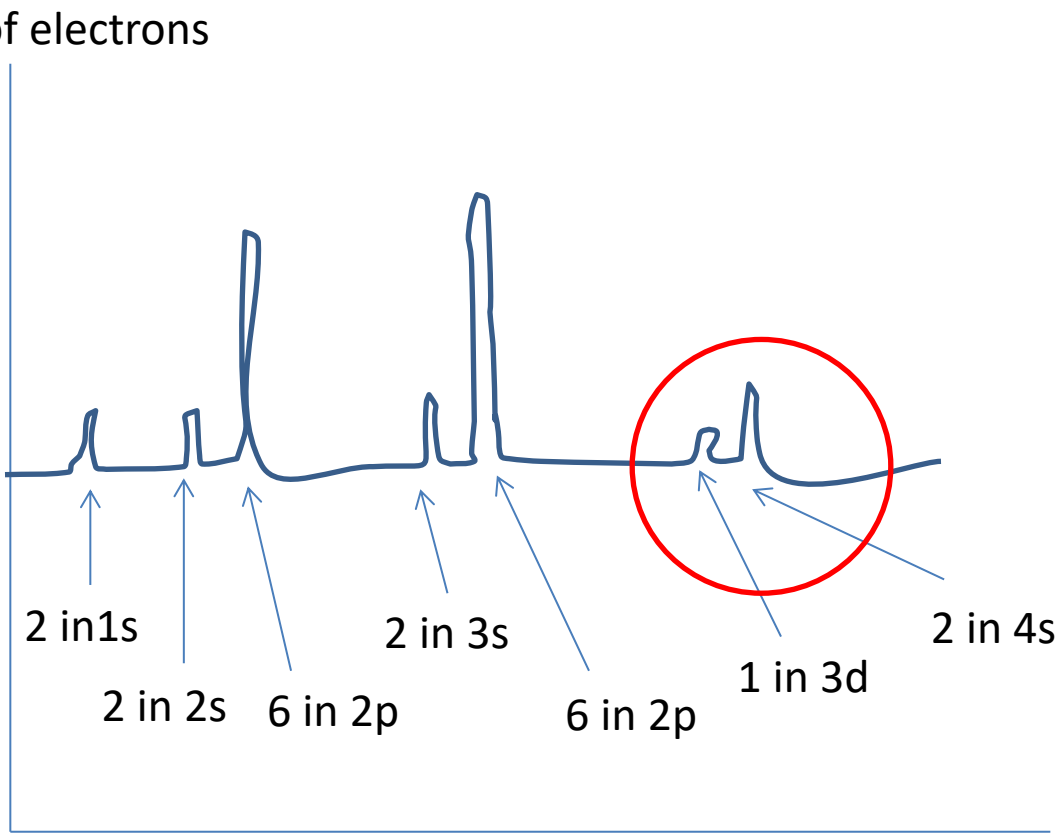


Scandium ($1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$)

*Notice that it takes more energy to remove an electron from 3d than from 4s.

This is because as electrons are added to 3d they shield 4s thus it's easier (takes less energy) to remove 4s electrons compared to 3d electrons.

Remember when transition metals make positive ions - it's the s electrons that are lost first!

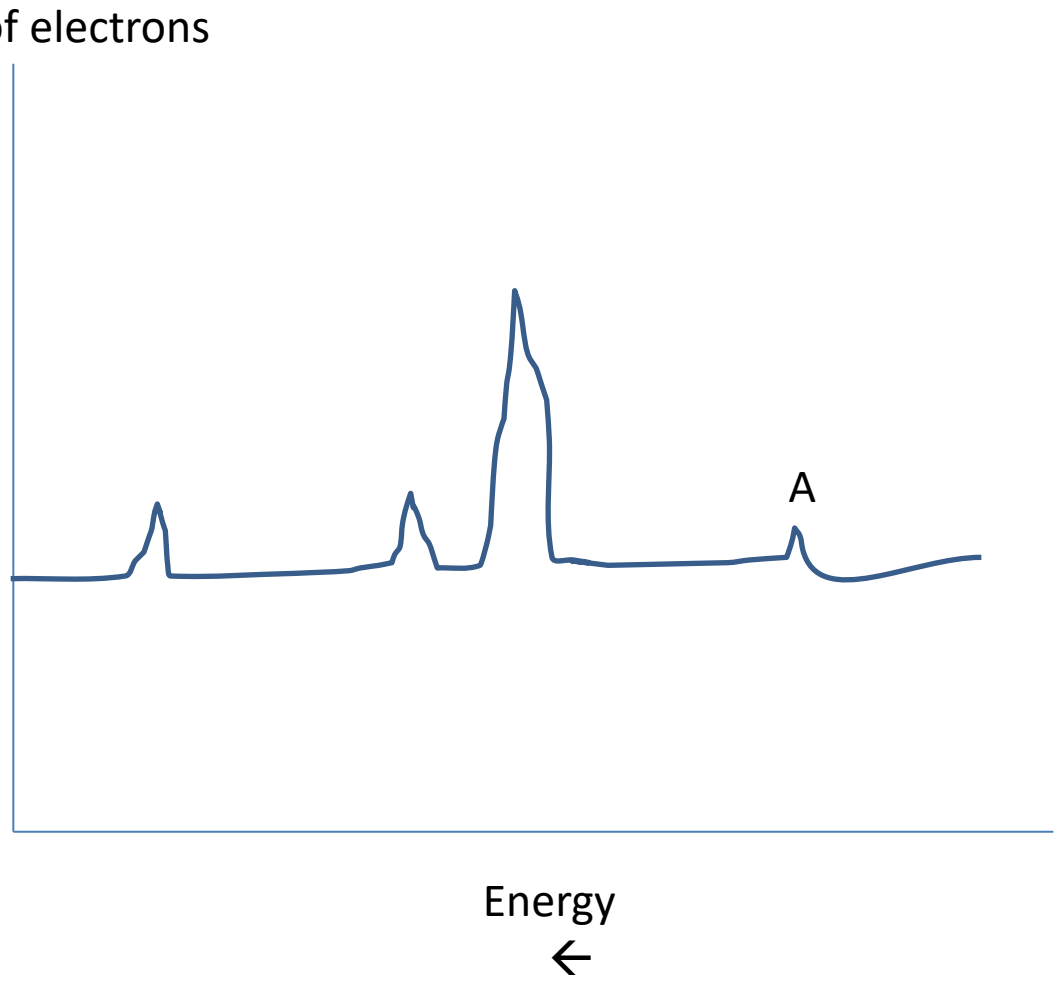


Example 1:

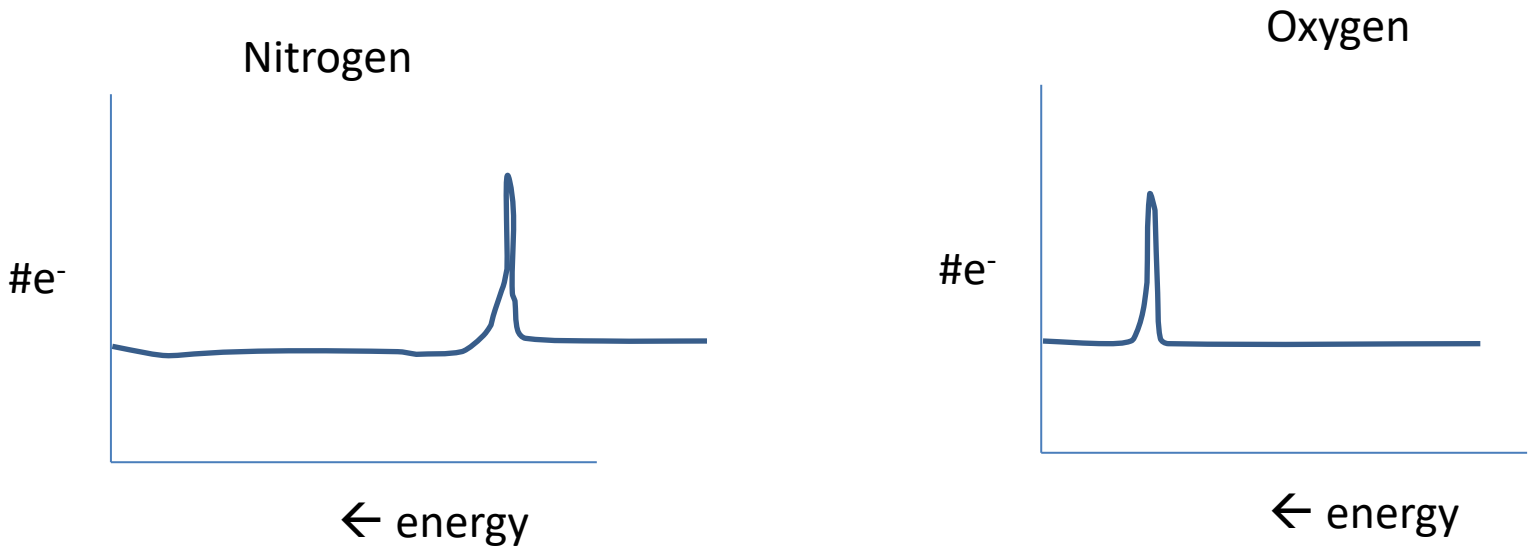
Identify the element whose
PES data is shown to the right.
Sodium

Why is one peak much larger
Than the others?
This peak represents 6 electrons
In the 2p sublevel the other
Peaks represent only 1 or 2
electrons

In which sublevel are the electrons
Represented by peak A
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 lower Effective nuclear charge (less protons) than oxygen

Example 3:

Draw the expected PES
Spectrum for the element boron