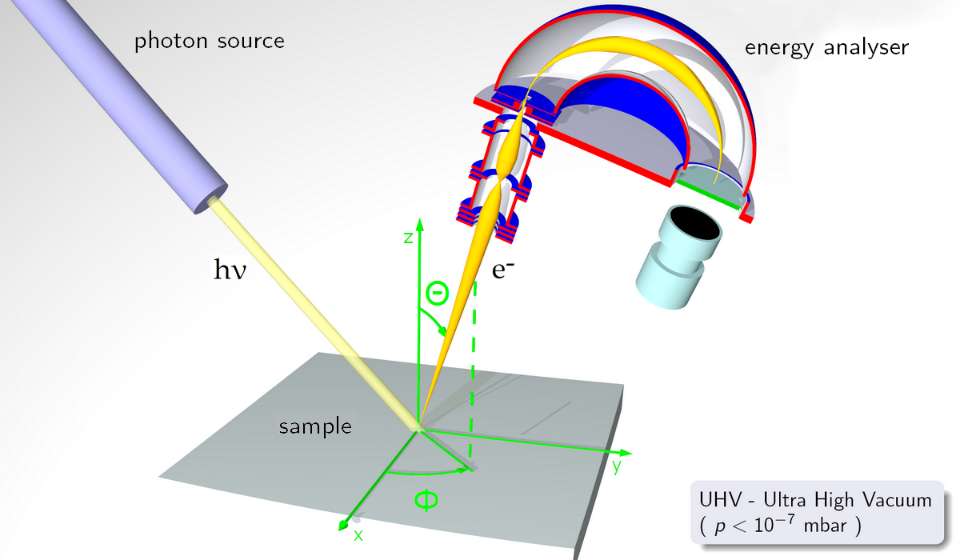
**The Photoelectric Effect**

Light exists as both a particle and a wave. Einstein observed the photoelectric effect as light in its particle form.

**The photoelectric effect** demonstrates that electrons are emitted from a metal surface when light strikes it *if* the frequency is high enough✨.

* If the **frequency (v)**, or # of waves per second that pass a point in space, is low, the metal absorbs the light.
* If the frequency is high, a specified number of electrons eject from the metal.

**PES**

**Photoelectron spectroscopy (PES)** is a method to compare the relative energies of atoms, ions, and molecules.

PES uses energy from electrons emitted through the photoelectric effect to provide insight about the electronic configuration of a sample.

**How Does it Work?**

When light of a certain frequency shines upon a sample, a limited number of electrons are emitted. The released energy reflects the energy or energy levels within an atom.

In viewing the PES chart of an element, you are also able to distinguish the different orbital levels and determine the electron configuration. Each of the peaks in a PES chart signifies a different orbital level, and the y-axis of the chart gives the number of electrons.

Here is a diagram putting all of these concepts together:

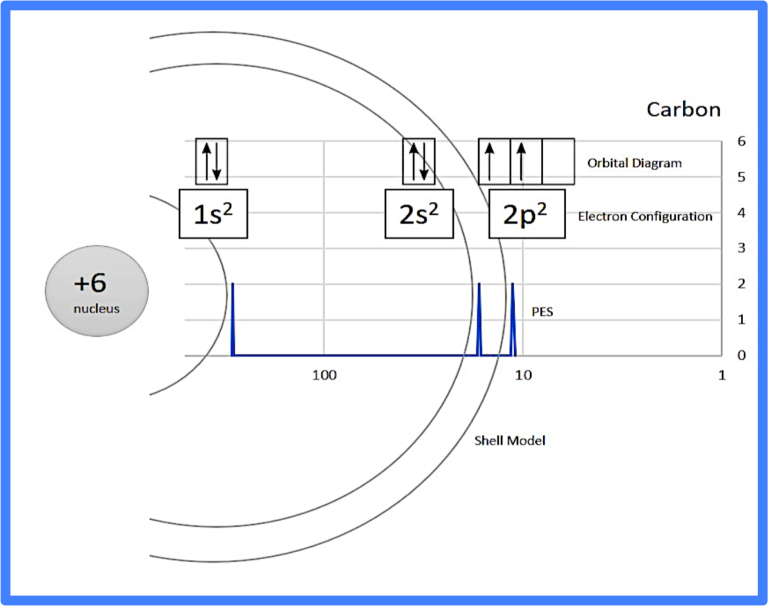


Image Courtesy of **[Chemdx](https://www.chemedx.org/sites/www.chemedx.org/files/pes_figure.png" \t "_blank)**

**Interpreting the Graph**

Here is a PES of Carbon without the markups. Let's dissect it.

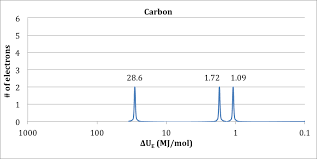


Image Courtesy of **[Chemmybear](http://www.chemmybear.com/aptipin2015/PES%20Presentation%204-18-15.pdf" \t "_blank)**

First, let's look at the axes. The x axis is the binding energy, which is synonymous with the ionization energy on this exam. The [**ionization energy**](https://fiveable.me/ap-chem/unit-1/periodic-trends/study-guide/J1NnoL1NHgd6B1dG2UZe) is the amount of energy required to remove a valence electron.

The closer an electron to the nucleus, the greater the ionization energy since the attraction between the negative electron➖ and positive nucleus➕ is the strongest.

This information should be able to tell us which side the nucleus is on in this diagram. It's on the left side, since the binding energy is greatest there (1000>0.1). So let's read the diagram from left to right.

The first orbital, as always, has to be 1s. Since the graph goes up to 2, there are 2 electrons in the 1s orbital.

The next orbital has to be 2s and the PES indicates there are 2 electrons in this orbital.

So far, the electron configuration seems to be 1s^2 2s^2.

There is one more peak though, which corresponds to the 2p orbital. However, this orbital isn't filled to maximum capacity, there are only 2 electrons in it.

The full electron configuration of this element is 1s^2 2s^2 2p^2. If I didn't tell you that this PES was for carbon, you should be able to guess it given the graph.

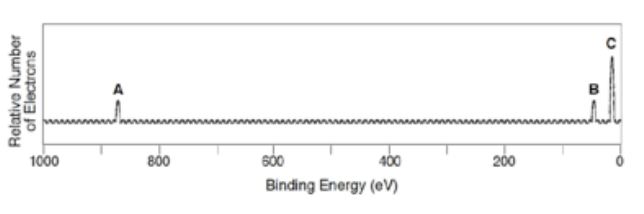
**Big Ideas**

* The *position*of the peak indicates how much energy is required to remove an electron from that sublevel.
* The *height*of the peak indicates how many electrons occupy that sublevel.

**Practice MCQ**

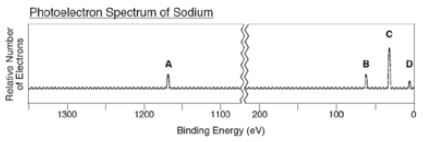
[**The next two questions are taken from a quizizz that kkehesci created.**](https://quizizz.com/admin/quiz/5cb3b5f3139b67001a9410be/ap-chem-pes)

1. **Refer to the photoelectron spectrum of neon shown below to answer the following question. Which of the following statements best accounts for peak A being to the left of peaks B and C?**



* a. The electron configuration of neon is 1s2 2s2 2p6.
* b. Neon has 8 electrons located in its valence shell.
* c. Core electrons of an atom experience a much higher effective nuclear charge than valence electrons.
* d. Peaks B and C show 1st ionization energies (I.E.) in neon, whereas peak A shows the 2nd I.E. of Neon.

**2. Which peak shows electrons closest to the nucleus? A, B, C or D?**



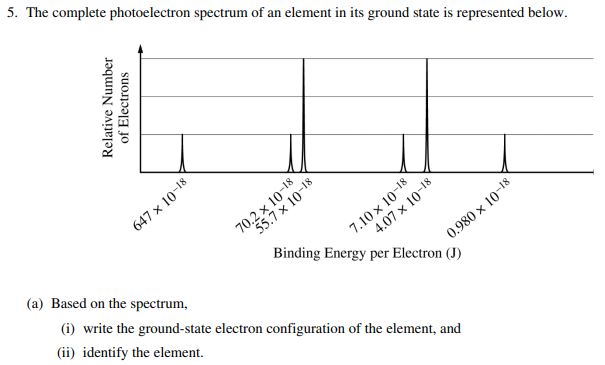
**Answers to MCQ**

The answer to #1 is C, Core electrons of an atom experience a much higher effective nuclear charge than valence electrons. This goes back to the concept that electrons closest to nucleus have a higher ionization energy/binding energy.

The answer to #2 is peak A. This goes back to that same exact concept. If asked about which peak corresponds to the energies of the valence electrons, you should say peak D.

**Previous AP Question**

This question is taken from the AP Chemistry Exam from [**2019**](https://apcentral.collegeboard.org/pdf/ap19-frq-chemistry.pdf).



In part a, they are asking you to simply write the configuration and identify the element. We just did this a few times! If you feel comfortable with this, try it on your own first before looking at the answer.

Since the binding energy is largest on the left, the peak on the left is the 1s orbital. The electron configuration is:

https://firebasestorage.googleapis.com/v0/b/fiveable-92889.appspot.com/o/images%2F-c9Hr7nMToV5W.JPG?alt=media&token=a4347fc2-4fc7-4403-a568-4f0a5fb3805d

You could use the noble gas shortcut here as well, but I often leave the electron configuration like this when given a PES.

To identify the element, just pull out your periodic table! You should get **Ca**.