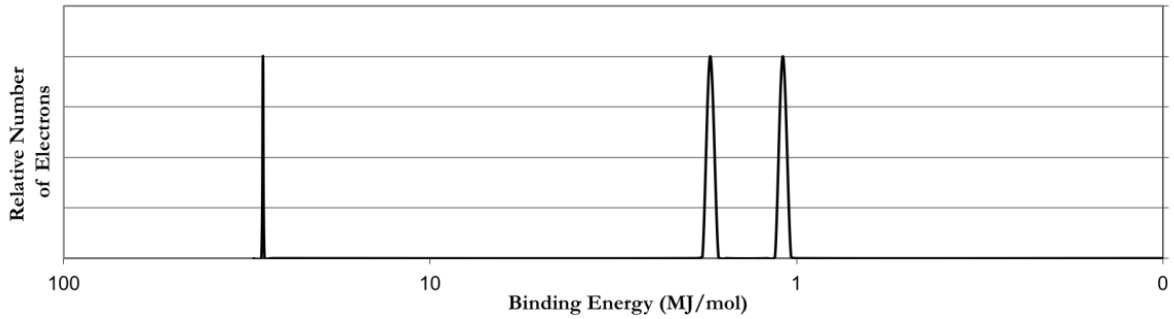
Worksheet: Photoelectron Spectroscopy & Electron Configuration

1. Refer to the PES spectrum below. Make note of the relative energies of each peak.

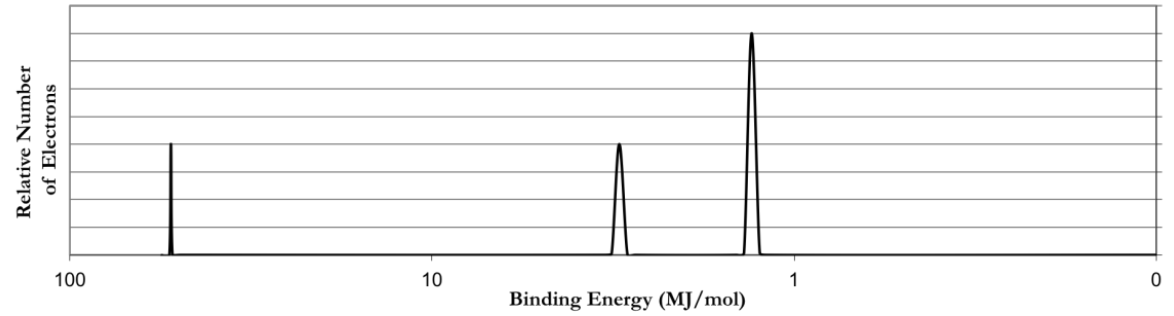


   a. How do the peak heights compare? What does this tell us about the relative number of electrons represented by each?

   b. If the peaks shown represent all of the electrons in this atom, identify the element.

   c. Which peak represents the core (innermost) electrons? Explain.

2. Refer to the PES spectrum below.



   a. How many electrons are represented in each peak?

   b. How many electrons does the atom contain? How many electrons are in its valence shell?

   c. Write the electron configuration for this element.

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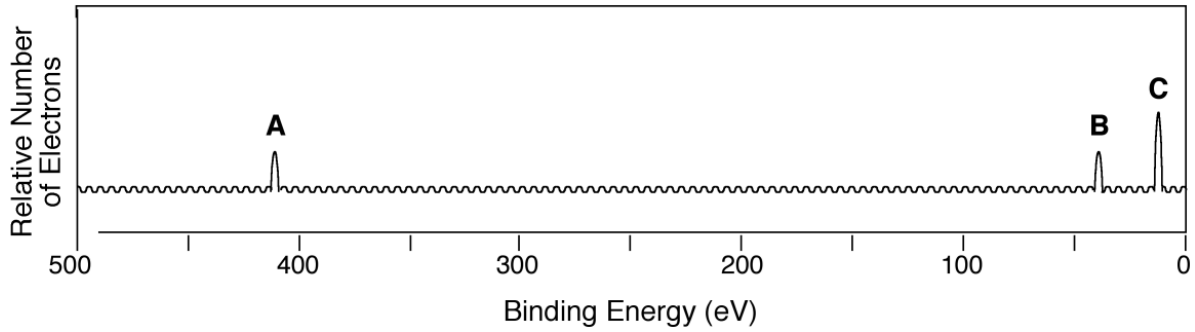
3. Consider the following PES spectrum



a. Using the plot, write the electron configuration of the element, and identify it.

b. Label each peak with the appropriate shell and subshell.

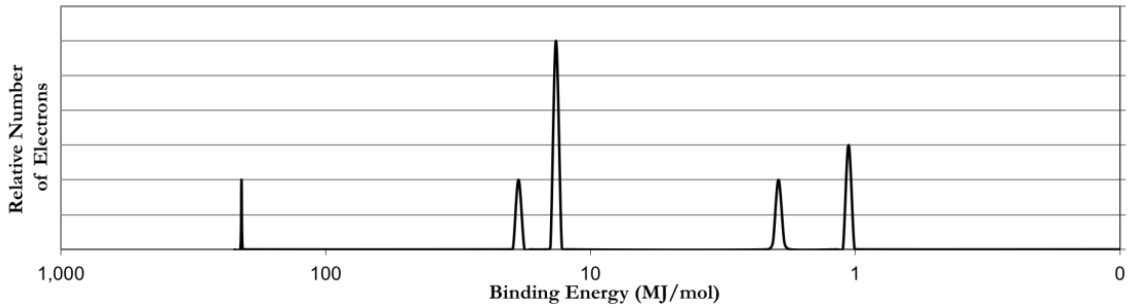
c. Suggest a reason for the huge jump in energy between peak A and peak B.

d. This element has a very high first ionization energy *and* a very high electron affinity. Would you expect it to form a cation or anion? What would be the charge of the ion? Justify your answers.

e. Write the electron configuration for the ion.

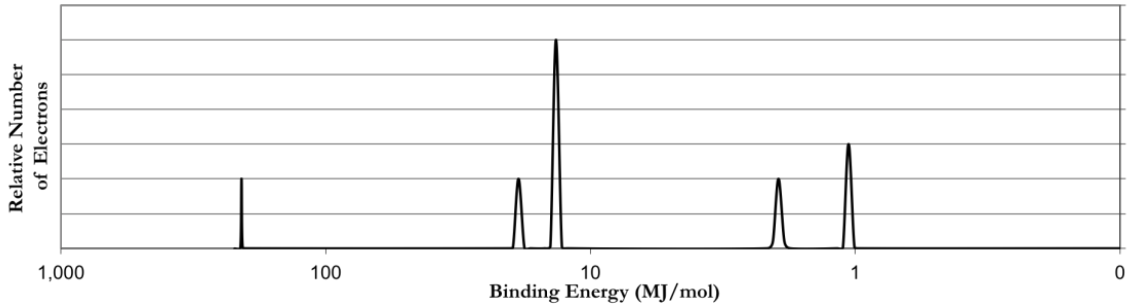
f. How would the radius of the ion compare to the radius of the neutral atom. Use Coulomb's law to justify your response.

4. Below is a photoelectron spectrum for the element phosphorus.



a. On the graph above, sketch in a PES spectrum for the element magnesium. How will the peak heights and relative energies of the peaks compare? Explain your reasoning.

b. Consider the photoelectron spectrum for sulfur



c. Write the electron configuration of sulfur.

d. Which subshell contains the electrons with the lowest ionization energy? Justify your answer.

e. How might you explain the fact that the 2p peak for sulfur is further to the left than the 2p peak for phosphorus, yet the 3p peak for sulfur is further to the right than the 3p peak for phosphorus?

f. Since potassium forms a cation, would you expect the electron affinity to be relatively low or relatively high? Explain.

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5. A student makes the following statement: "Since Ca^{2+} and Ar, and S^{2-} are isoelectronic, their PES spectra are identical." Is this statement true or false? Justify your answer.

6. Write the electron configuration for the following elements or ions. Then, indicate how many peaks you would expect to see in a PES spectrum.
   a. P
   b. Br^-
   c. Zn^{2+}
   d. Ba
   e. Co^{2+}

7. Identify the element given the electron configurations
   a. $1s^2\ 2s^2\ 2p^3$
   b. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$
   c. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^4$
   d. $[Ne]\ 3s^2\ 3p^2$
   e. $[Xe]\ 6s^2$

8. Identify four ions that are isoelectric with xenon. Rank them in order of increasing atomic radius.

9. Which elements fit the following descriptions:
   a. Has a valence shell configuration of $4f^{14}\ 5d^{10}\ 6s^1$
   b. Halogen with the lowest ionization energy
   c. Has 13 more electrons than argon
   d. The smallest nonmetal
   e. Group 4A element with the largest ionization energy
   f. Its 3+ ion has the electron configuration $[Kr]\ 4d^{10}$