AP Chem
HW #8-3: Photoelectron Spectroscopy Worksheet

1) In a photoelectron spectrum, photons of 165.7 MJ/mol strike atoms of an unknown element. If the kinetic energy of the ejected electrons is 25.4 MJ/mol, what is the ionization energy of electrons that were ejected?

165.7
− 25.4
140.3 MJ/mol

2) What determines the position and the height (intensity) of each peak in a photoelectron spectrum?

# of e⁻

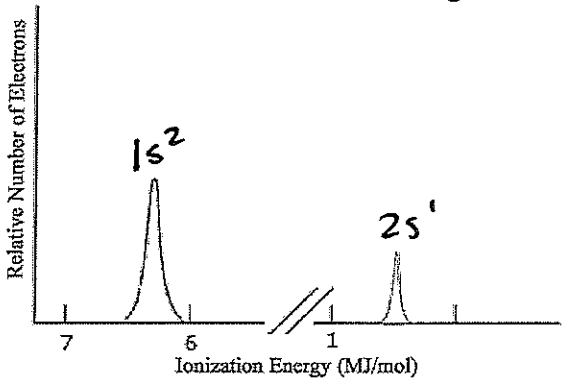
3) Why is the distance of the energy level from the nucleus important in determining the corresponding peak position in the photoelectron spectrum?

$F = \frac{q^+ q^-}{d^2}$ ← distance determines force of attraction

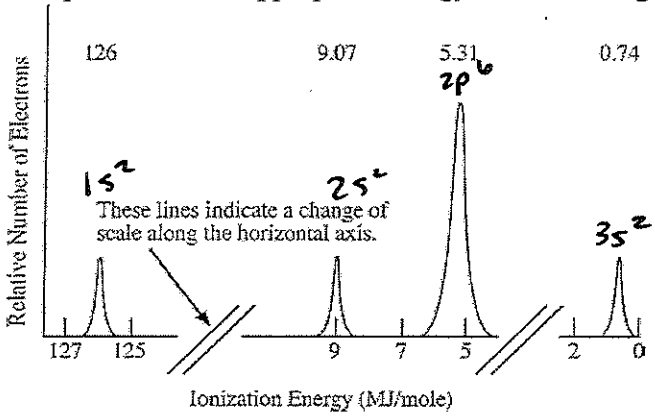
4) The ionization energy of an electron from the first energy level of lithium is 6.26 MJ/mol. The ionization energy of an electron for the second energy level of lithium is 0.52 MJ/mol.

a) What is the electron configuration for lithium? $1s^2 2s^1$

b) Below is the photoelectron spectrum for lithium; label each peak with the energy sublevel, number of electrons, and the values of the ionization energies stated above.

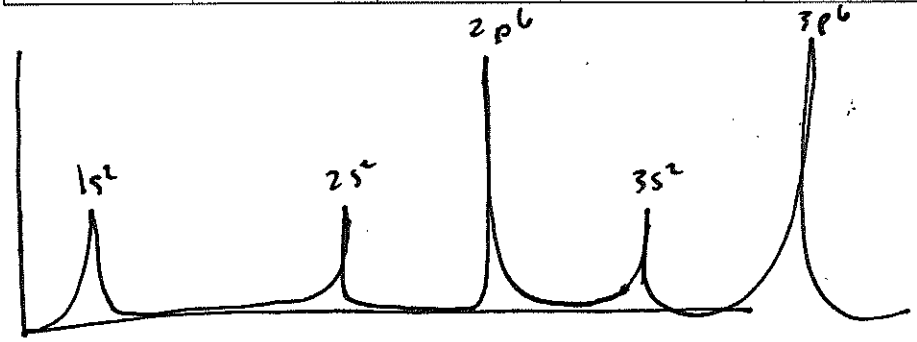


5) Identify the element in the photoelectron spectrum shown below. Mg
What is the electron configuration of this element? $1s^2 2s^2 2p^6 3s^2$.
On the diagram, label all peaks with the appropriate energy sublevel designations and # of e⁻.



6) Based on the ionization energies provided below, draw a photoelectron spectrum for argon. Indicate the relative intensities and positions of all peaks.

$1s^2$	$2s^2$	$2p^6$	$3s^2$	$3p^6$
309.0	31.5	24.1	2.83	1.52



7) Look at the previous three questions (#4, #5 and #6). The first peak (the peak all the way at the left) for each of the elements in those questions all correspond to the ionization energy for the 1s electrons. Why do the values for these ionization energies increase when one goes from lithium (6.26 MJ), to the element in question #5 (127 MJ) and then to Argon (309 MJ)?

They all have a similar distance from the nucleus
Large # of p^+ causes a greater Coulombic attraction.
$F = \frac{q^- \cdot q^+}{d}$ ← Larger Nucleus
← similar energy level

8) Identify if either of the following statements is correct. If correct, explain why. If not correct, explain why not:

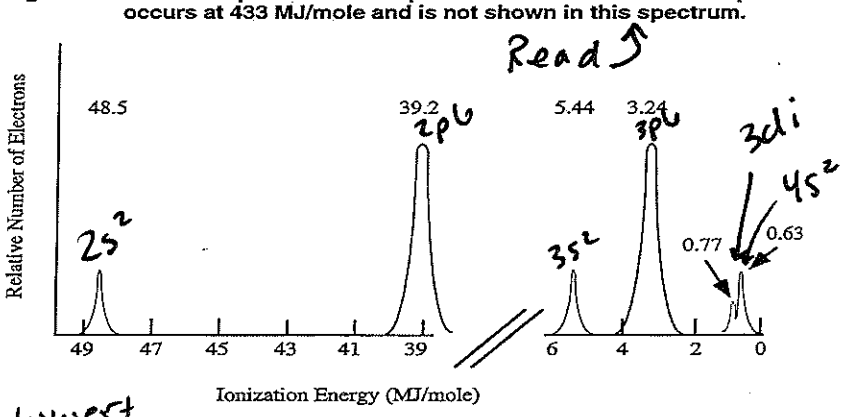
a) The photoelectron spectrum of Mg^{2+} is expected to be identical to the photoelectron spectrum of Ne.

False, Ne has less p^+, so it will have less energy Needed to remove.
Peaks shift →

b) The photoelectron spectrum of ^{35}Cl is identical to the photoelectron spectrum of ^{37}Cl.

yes. extra Neutrons does Not affect Coulombs law.

9) Examine the graph at the right.



a) Which electron(s) is represented by the 0.77 peak? 3d¹

b) Which electron(s) is represented by the 0.63 peak? 4s²

c) Scandium loses two electrons when forming Sc^{2+}. Which electrons are most likely to be removed? 4s²
outtermost - lowest energy Needed to Remove.
Explain the logic for your answer. →