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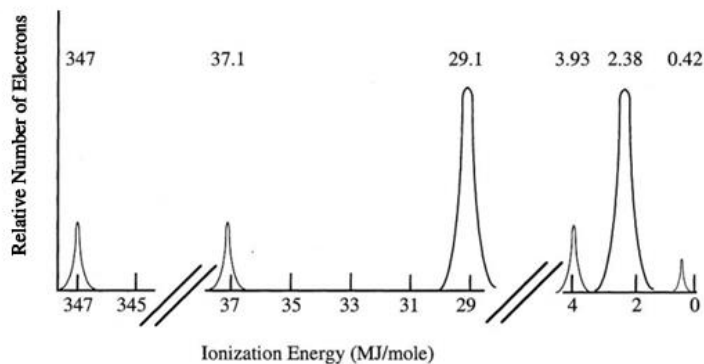
AP Chemistry 30 – Lab Activity 3: Photoelectron Spectroscopy

Learning Objective

- Analyze graphs of photoelectron spectroscopy to determine electron configuration and relative ionization energies of electrons.
- Relate graphs of photoelectron spectroscopy to the quantum mechanical model of the atom.

Discussion

Spectrum #1: Potassium



1. Label each peak on the graph with the subshell each represents (1s, etc.).
2. Write the electron configuration of potassium.

3. Which electron will be removed from this neutral atom to form an ion? Circle the electron on the graph, then explain why this is the case, using evidence.

4. What would you expect a PES spectrum of calcium to look like, compared to the graph for potassium. (Remember that calcium has one more electron, AND one more proton. What does this do to the effective nuclear charge?)

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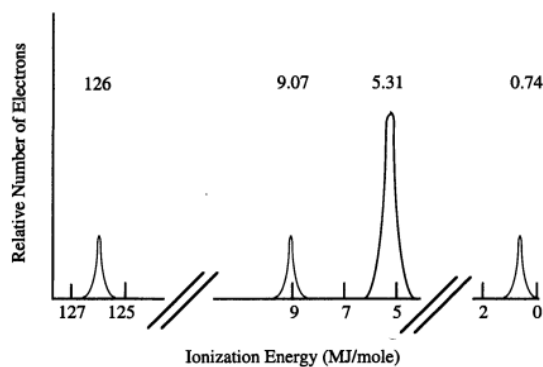
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Table 1. Ionization energies (MJ/mole) for selected elements.

Element	1s	2s	2p	3s	3p	3d	4s
K	347	37.1	29.1	3.93	2.38		0.42
Ca	390	42.7	34.0	4.65	2.90		0.59
Sc	433	48.5	39.2	5.44	3.24	0.77	0.63

5. The table above shows the ionization energies for an electron in each orbital for potassium, calcium and scandium. Why would the value be higher for the electrons in the 4s orbital for calcium than those for potassium?

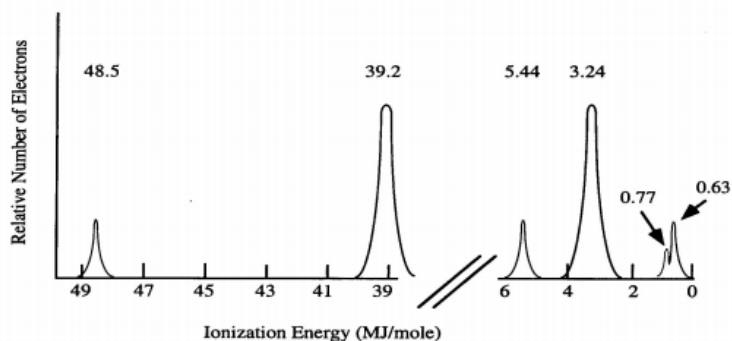
Spectrum #2: Mystery Element



6. What element is shown in the spectrum above? Label each peak on the graph with the subshell each represents (1s, etc.). _____

Spectrum #3: Scandium

Figure 2. Simulated photoelectron spectrum of scandium. The 1s peak occurs at 433 MJ/mole and is not shown in this spectrum.



7. Write the noble gas configuration for scandium.

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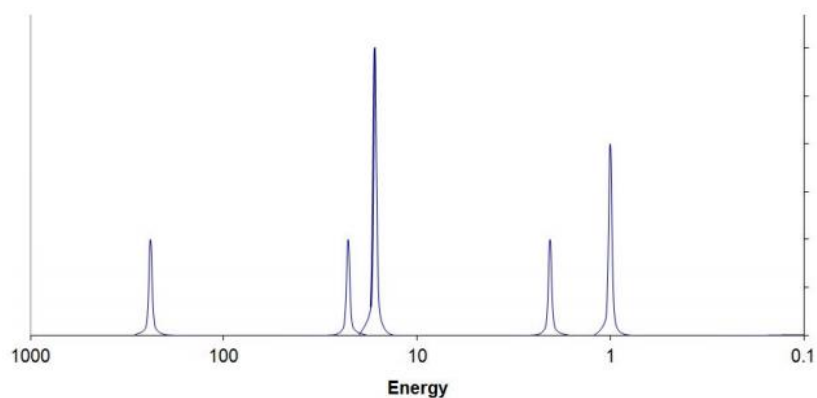
8. Identify which subshell is represented by the 0.77 peak _____ and the 0.63 peak.

9. How can you use this graph as proof that the 4s subshell fills before the 3d subshell?

Spectrum #4: Sulfur

Successive Values of Ionization Energies

Element	I_1	I_2	I_3	I_4	I_5	I_6	I_7
S	1000	2252	3357	4556	7004	8496	27,107



10. The PES of sulfur is above, as well as a table of successive ionization energies. (The table is in kJ and the graph is in MJ).
- There is only one peak on the graph that matches up to the table. Circle the peak.
 - Hypothesize why none of the other peaks match up.
