AP Chemistry
Supplemental Problem PES

PES values of orbital ionization energies for elements 11-21

	Na	Mg	Al	Si	P	S	Cl	Ar	K	Ca	Sc
2s	6840	9070									
2p	3670	5310	7790								
3s	500	740	1090	1460	1950	2050	2440	2820	3930	4650	5440
3p			580	790	1010	1000	1250	1520	2380	2900	3240
3d											770
4s									420	590	630

1. Why are the values for the 1s electrons missing? The 1s electrons are held so tightly to the nucleus that the method of PES will not measure very high ionization energies. More energy is required to remove those electrons than what this tool can provide.

2. Why are the values for the 2s electrons from Al through Sc missing, whereas they exist for Na and Mg?
The nuclear charge of Al and those higher atomic numbers are greater than that for sodium and magnesium, so the ionization energies of the closely held electrons in the 2s shell are greater than the energy of the ionizing photons of the PES.

3. Use Coulomb's law to explain why sodium's 3s energy value is lower than it's 2s subshell.
The 3s electron is farther from the 11+ nuclear charge than are the 2s electrons. Coulomb's Law states that the energy between the nuclear charge and the electrons is inversely proportional to the distance. Greater the distance from the nucleus, the lower the ionization energy.

4. How do the values listed for magnesium give evidence for the shell model of the atom?
Ionization energies decrease as the shell #'s increase from 2s, 2p, 3s and so on. The data shows that the ionization energies fall into different energy levels or shells.

5. Predict the relative intensities of the three peaks corresponding to the energy values given for the Al atom. Justify your answer. Each energy value listed represents the ionization energies of a particular subshell: 2p, 3s, 3p. The intensity in a PES represents the number of e- in a subshell. Subshell 2p (representing 6 e-) will have an intensity three times as great as subshell 3s (two e-); and six times as large as subshell 3p (one e-).

6. Determine the trend in energy values from left to right along the row corresponding to the 3s subshell.
From left to right along any row ionization energies increase with increasing nuclear charge.

7. Suggest a plausible reason for your answer to question 6.
As the nuclear charge gets larger, the energy of attraction for electrons becomes greater according to Coulomb's law: $E=Q_1Q_2/d$

8. Why does only scandium show an energy value for the 3d sublevel?
Only Sc has a 3d electron in its ground state electron configuration. Sc: $[Ar]4s^2 3d^1$