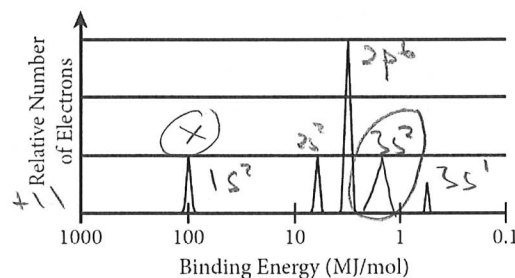


1) The complete photoelectron spectrum of an unknown element is given.

- a) Draw an X above the peak that corresponds to the orbital with electrons that are, on average, closest to the nucleus. Justify your answer in terms of Coulomb's law. 2019 CED

Larger binding E = greater effective charge



- b) Based on the spectrum, write the complete electron configuration of the element.  $1s^2 2s^2 2p^6 3s^1$

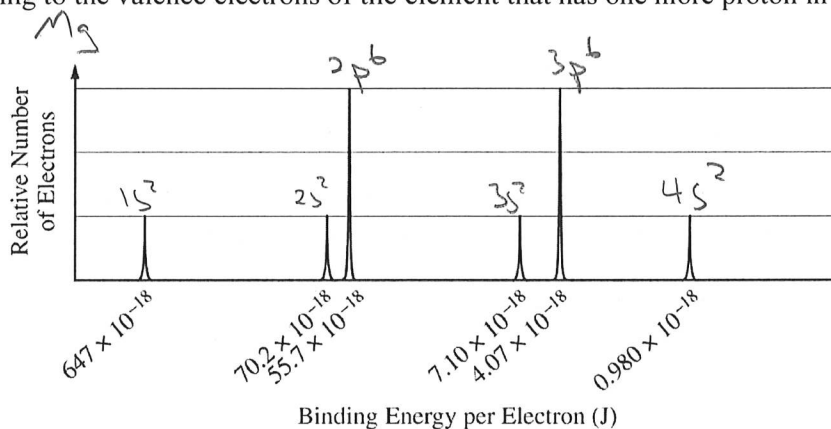
- c) On the graph, draw the peak(s) corresponding to the valence electrons of the element that has one more proton in its nucleus than the unknown element has. Mg

5) The complete photoelectron spectrum of an element in its ground state is represented by the diagram. 2019 FRQ

- a) Based on the spectrum,  
i) write the ground-state electron configuration of the element, and

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

- (ii) identify the element. Ca



- b) Calculate the wavelength, in meters, of electromagnetic radiation needed to remove an electron from the valence shell of an atom of the element.

$$E = \frac{hc}{\lambda} \quad \lambda = \frac{hc}{E} = \frac{(6.626 \times 10^{-34} \text{ J}\cdot\text{s})(2.998 \times 10^8 \text{ m/s})}{0.980 \times 10^{-18} \text{ J}} = 2.03 \times 10^{-7} \text{ m}$$

Answer the following questions related to sulfur and one of its compounds. 2009 6

- a) Consider the two chemical species S and  $S^{2-}$ .

- i) Write the complete electron configuration of each species. (2pts)

$S = 1s^2 2s^2 2p^6 3s^2 3p^4$

$S^{2-} = 1s^2 2s^2 2p^6 3s^2 3p^6$

- ii) Explain why the radius of the  $S^{2-}$  ion is larger than the radius of the S atom. (1pt)

Both have 16 protons,  $S^{2-}$  has more  $e^-$  so a lower effective nuclear charge

- iii) Which of the two species would be attracted into a magnetic field? Explain. (1pt)

S - two single electrons in orbitals

- b) The  $S^{2-}$  ion is isoelectronic with the Ar atom. From which species,  $S^{2-}$  or Ar, is it easier to remove an electron? Explain. (1pt)

$S^{2-}$  - larger radius, lower effective nuclear charge

Using principles of atomic and molecular structure and the information in the table, answer the following questions about atomic fluorine, oxygen, and xenon, as well as some of their compounds. 2008 5

- a) Write the equation for the ionization of atomic fluorine that requires  $1,681.0 \text{ kJ mol}^{-1}$ . (1pt)



- b) Account for the fact that the first ionization energy of atomic fluorine is greater than that of atomic oxygen. (You must discuss both atoms in your response.) (1pt)

F has 9 protons +  $e^-$  = greater effective nuclear charge (O has 8 of each)

- c) Predict whether the first ionization energy of atomic xenon is greater than, less than, or equal to the first ionization energy of atomic fluorine. Justify your prediction. (1pt)

Less S than - more E-levels (5 vs 2) = greater distance from nucleus = lower effective nuclear charge

Atom	First Ionization Energy (kJ mol <sup>-1</sup> )
F	1,681.0
O	1,313.9
Xe	?