Unit 4: Atomic Structure STUDY GUIDE

1. Explain what Rutherford's model of the atom explained based on the data that he discovered.

2. Describe what data was discovered in the late 1800s that required that a modifications to the atomic model.

3. Describe what Bohr's model explained about the atom, based on evidence.

4. Describe the problems with Bohr's model and how these were solved with the development of the quantum theory of the atom by DeBroglie, Heisenberg and others.

   You have information on these 4 questions in your notes. In your book on pages 299-308 there is also a weak discussion of the development of the atom. It is interesting, but I think the book discussion is heavy on math, weak on theory. Here is a website that I think provides a more detailed description of how the theories were developed BASED ON EXPERIMENTAL EVIDENCE.

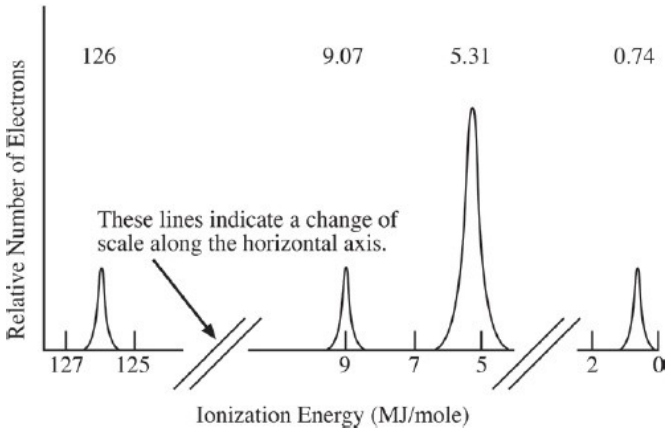
   http://www.chem1.com/acad/webtut/atomic/qprimer/index.html

   Scroll down to Q. 21-28 on the web page for pertinent information.

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

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

7. Identify the element in the photoelectron spectrum shown below. *Briefly explain* your reasoning.



8. Identify if either of the following statements is correct. *Briefly explain* your reasoning:

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

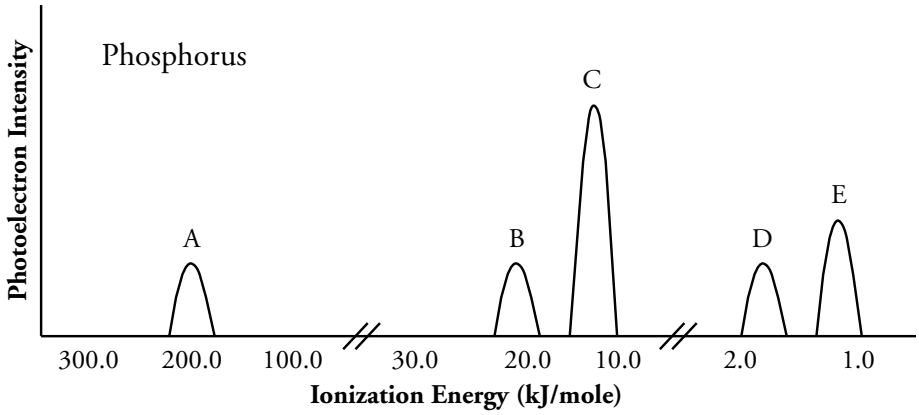
   b) The photoelectron spectrum of ^{35}Cl is identical to the photoelectron spectrum of ^{37}Cl.

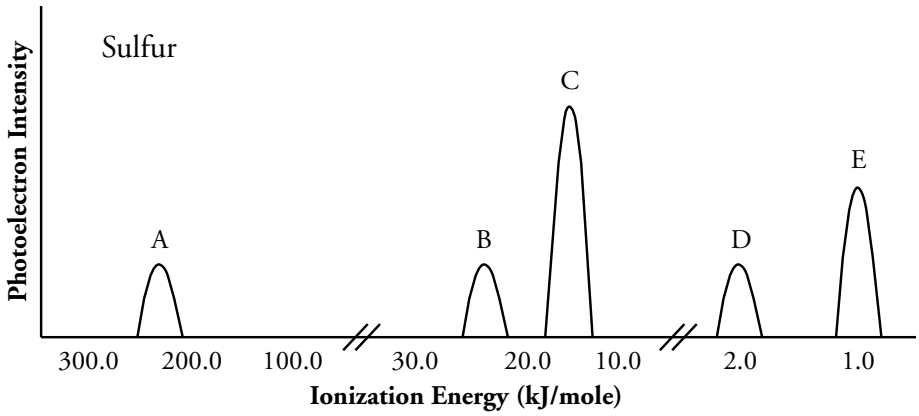
- Use the diagrams of the photoelectron spectrum of Phosphorous on the **next page** to answer the following questions.

9. Label the energy sublevels for each peak of the Sulfur and Phosphorous spectrum.

10. Explain why most of the peaks in the sulfur spectrum are shifted to the left relative to the peaks in the phosphorous spectrum.

11. Explain why peak E in the sulfur spectrum is shifted slightly right compared to peak E in the phosphorous spectrum





12. PES experiments frequently use an X-ray wavelength of 0.8340 nm. Recall that the energy of a photon can be calculated using the equation $E = hc/\lambda$.

c) Calculate the energy of the X-ray photon used in the PES experiment described.

d) Calculate the ionization energy of a photoelectron with a kinetic energy of 2.372×10^{-16} J. Include appropriate units.

e) The value you have calculated is the ionization energy of a single electron. Generally we express the ionization energy of a mole of electrons. What would be the ionization energy of a mole of the electrons from part *a*? Include appropriate units and significant figures.

13. How are photoelectron spectroscopy and the photoelectric effect related?

14. What is the maximum wavelength of light that could be used to eject an electron with an ionization energy of 340 kJ/mole?

15. Photoelectron spectroscopy experiments must be performed under ultra-high vacuum conditions. Propose a reason for these extreme conditions.