12. Photoionization

As atoms absorb light, the energy of the electron cloud increases to specific energy levels. These energy levels are determined by the resonant frequencies between the light and matter. However, if an electron’s energy increases past a certain threshold, it will no longer be held in the atom. Ionization is a process where an electron is removed from an atom; photoionization is therefore the process of ionization through the absorption of light.

This activity will help guide you through the process of photoionization – the removal of an electron from an atom through the absorption of light (see http://goo.gl/bqbJs7 pp. 16 – 23 for more details).

1) Based on what you have learned in class, why do the energy levels become increasingly close together at higher energy levels?

2) On the diagram on the left, label the energy level $n = \infty$ at the theoretical energy level value (as done in class). What is the energy value of $n = \infty$?

3) Based on the energy diagram on the left, what does it mean when electron has a positive energy?

4) On the diagram, draw an arrow representing the transition of an electron from the ground state to its removal from the atom.

5) What is the lowest possible energy of an absorbed photon needed to remove the electron from the ground state in a hydrogen atom?
6) What would happen if a photon with a frequency greater than the threshold frequency were to interact with an atom?

7) Using your answer to (5), calculate the threshold frequency (lowest frequency needed to remove the electron) for the hydrogen atom. (*Hint: ΔE = hν*)

8) As you learned in class, the Bohr model can be used for other single electron atoms. If Z = 2 for helium, calculate the energy of the ground state (n = 1 energy level) for He⁺ using the Bohr model.

9) Based on your work in the previous questions, determine the threshold frequency for removing the ground-state electron from He⁺.