ATOMIC STRUCTURE PROBLEM SET

1. Green light has a wavelength of approximately 500 nm. Calculate the following quantities for this green light:

   (a) the frequency,
   (b) the energy in joules per photon,
   (c) the energy in kJ per mole of photons.

2. Assume you are an engineer designing a space probe to land on a distant planet. You want to use a switch that works by the photoelectric effect. That is, light falling on the surface of a metal causes the metal to release some electrons, which flow to a positively charged pole and close the electrical circuit. The metal you wish to use in your device requires 6.70×10^{-19}J(per atom) to remove an electron. You know that the atmosphere of the planet on which your device must work filters out all wavelengths of light less than 540 nm. Will your device work on this planet in question? Why or why not?

3. An excited hydrogen atom emits light with a frequency of 1.141×10^{14} Hz to reach the energy level for which n = 4. In what principal quantum level did the electron begin?

4. The energy levels available to an electron in a hydrogen-like species (i.e. a species having only one electron) is given by the equation:

   $$E_n(\text{in Joules}) = -2.178 \times 10^{-18} Z^2/n^2$$

   Calculate the ionization energy (in kJ/mol) for the one electron species C^{5+}.

5. In the hydrogen atom the n=2 to n=1 transition gives rise to a spectral line at 121.6 nm. Consider the C^{5+} ion and calculate what transition would yield a spectral line having the same wavelength as for the n=2 to n=1 line in the H-atom.
   In other words the transition from n=? to n=? for the C^{5+} ion would give rise to a line at 121.6 nm.

6. What is the maximum number of electrons in an atom that can have these quantum numbers:

   (a) n = 4
   (b) n = 5 and s = +1/2
   (c) n = 3 and l = 2
   (d) n = 1, l = 0 and m = 0
   (e) n = 0, l = 0 and m = 0