

Chemistry 181H

Fall, 2008

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Practice Problem Set

Do: before second exam

1. Calculate the energy emitted and the wavelength of that photon when a He^+ ion undergoes a transition from the $n=3$ to the $n=2$ state in the Bohr model. Describe the degenerate states in this ion that have $n=3$. Describe the degenerate states in a neutral helium atom that have $n=3$.
2. Calculate the wavelength of an electron emitted from a clean cesium surface by the absorption of the photon calculated in the previous problem. (The property of Cs necessary to solve this problem is 2.1 eV from some table on the web. Extra: compare the values of the FIP and work function for Cesium.)
3. A gold atom is free to move around on a two-dimensional surface that is $L_x=40$ nm and $L_y=50$ nm but it doesn't have enough energy to leave that surface. What are the quantum numbers and the energy of the first excited state of this system? Is the first excited state degenerate for this system? Estimate the probability that the gold atom would be in the corner of the surface $0 < x \leq 10$ and $0 < y \leq 10$ in the ground state.
4. Explain the fact that changes in the vibrational motion of molecules are generally associated with a single electromagnetic energy but changes in the electronic excitation are associated with many discrete energies. Estimate the energy change associated with a change in the vibrational motion of a N_2^+ molecular ion. Hint: The force constant can be found in Figure 6.18 of the text.
5. Sketch the radial wavefunction and the radial distribution function for AO's with the following quantum numbers $[(n, \ell, m_\ell)]$: (5,2,2); (3,1,1); (6,5,-5); (6,0,0). What is the requirement on the value of "n" in the following examples and many planar nodes are there in the hydrogenic AO with quantum numbers: (n,4,-4); (n, ℓ ,-5); (n,5, m_ℓ)?
6. Consider two independent atoms in vacuum: strontium and tin. Which one of these atoms do you expect to be larger? Is one, none, or both of these atoms paramagnetic? Which do you expect to have a larger FIP? Most of the strontium atoms have a mass of 88 g/mol, how many neutrons are in the nuclei of these atoms?
7. Consider the molecule C_2 . Write the LCAO-MO electronic configuration for this molecule. Is it diamagnetic? The carbide anion is known, C_2^{2-} . Indicate the bond order for both species. Which species would you expect to have the larger vibrational force constant?