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CHEM 3520 – Physical Chemistry II

EXAM #2

Wednesday, February 27, 2002

INSTRUCTIONS:

1. Show all work, including all formulas used.
2. Provide all units.
3. Keep your work covered.
4. **PART II is at 12:00 TODAY!!!!**
5. GOOD LUCK!

Part I – 57 pts total (out of 105 pts, which includes 5 pts extra credit)

Short answer. (Total: 22 pts)

1. What is the electronic configuration of As? (2 pts)
2. Show a wavefunction for a hydrogenic atom. What are the names of the parts of the wavefunction? (4 pts)
3. Considering the orbitals of a hydrogenic atom, what is the degeneracy of the level with the principal quantum number of three? Explain how you arrived at this solution. (4 pts)
4. Address each of the following. **Be sure to justify your responses.** (12 pts)
 - (a) How many electrons are in 4f? How many orbitals are possible? How many radial nodes?
 - (b) Is a 3f state possible?
 - (c) Is the transition $3f \rightarrow 2d$ possible?
 - (d) Is the transition $3s \rightarrow 4s$ possible?
 - (e) How many electrons are possible in an M shell?

Definitions. (Total: 12 pts)

5. Explain what is meant by each of the following. (12 pts)
 - (a) Hund's rule
 - (b) Aufbau principle
 - (c) Pauli principle
 - (d) Triplet

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(e) Valence electrons

(f) Ionization energy

Problems. (Total: 18 pts)

6. What are the possible states arising from d^2 ? (8 pts total)
7. Are the wavefunctions describing a 1s and 2s electron orthogonal? (Prove your result.) (10 pts)

Extra Credit. (Total: 5 pts)

- * Calculate the probability that the electron in a Li^{2+} ion in the 1s state is less than the Bohr radius? (Set up the problem only!) (5 pts)

Part II – 48 pts total (out of 105 pts, which includes 5 pts extra credit)

Short answer. (Total: 6 pts)

1. Write the complete wavefunction for an electron with an orbital angular momentum of two, a principal quantum number of three, and an orbital magnetic quantum number of one. (2 pts)
2. Which plot represents (a) figure 1? (b) figure 2? (See attached.) (4 pts)

Definitions. (Total: 11 pts)

3. Compare and contrast the notations s, p, d, f and S, P, D, F. Under what circumstances would an f electron give an F state? (6 pts)
4. In Chapter 13, we have discussed several types of momenta. Explain what each of the following is: (5 pts)
 - (a) angular momentum
 - (b) orbital angular momentum
 - (c) spin angular momentum
 - (d) total angular momentum.

(Please note: A discussion in terms of quantum numbers or other “letter” notation is not a complete discussion.)

Problems. (Total: 31 pts)

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7. Solve the following. (25 pts) Be sure to label which solution corresponds to which letter (i.e. a, b, or c) below!
- (a) What is the average distance that an electron in a 2p orbital will be found from the nucleus?
 - (b) What is the most probable distance between an electron in a 2p orbital and the nucleus?
 - (c) Is an electron further from the electron on average when it is in a 2s orbital or a 2p orbital? (Justify your answer mathematically!)
6. What two electrons can arise to the states 3P_2 , 3P_1 , 3P_0 , 1P_1 ? (6 pts)