

# Chemistry 432

## Advanced Inorganic Chemistry

### Problem Set 1 - 20 Points

**Due: Friday, Sept. 2.**

Based on the Reading: Meissler and Tarr (M & T), Sections 1.1-1.2 and 1.5-1.6 in Chapter 1 and Sections 2.1-2.2 in Chapter 2. Note that much of this is review of CHM 211-212, but some (subsection 2.2.1 and some of 2.2.2) is covered in CHM 412. For those of you enrolled in CHM 412 concurrently, we will be learning about more about wavefunctions in the first few weeks.

- (3 pts) M & T, 2-2 Using the equations  $E = R_H(\frac{1}{2^2} - \frac{1}{n_h^2})$ , determine the energies and wavelengths of the four visible emission bands in the atomic spectrum of hydrogen arising from  $n_h = 4, 5, 6$ . The red line, corresponding to  $n_h = 3$  was calculated in exercise (example) 2.1 (see M&T page 20). *Inverse meters is a common unit used for energies in spectroscopy.*
- (2 pts) (a) Find the possible values for the  $l$  and  $m_l$  quantum numbers for a  $3p$  electron, a  $4f$  electron and a  $5g$  electron. (b) Find the possible values for all four quantum numbers for a  $5f$  electron.
- (3 pts) Give electron configurations for (a) V (b) As (c)  $Pt^{2+}$  (d)  $Fe^{3+}$  (e) I (f)  $Ta^{2+}$  (g)  $Cu^+$  (h)  $Re^+$
- (4 pts) Using a right-hand coordinate system, draw an iconic representation of all the s, p and d atomic orbitals. Use the same coordinate system for each and clearly show the spatial relationship of the orbitals to the axes. Use shading, lines or colors to indicate different signs for lobes. Draw these carefully and clearly for credit.
- (2 pts) M & T, 2-16 Determine the coulombic and exchange energies for the following configurations, and determine which configuration is favored (of lower energy):
  - $\underline{\uparrow} \quad \underline{\uparrow} \quad \text{and} \quad \underline{\uparrow\downarrow} \quad \underline{\quad}$
  - $\underline{\uparrow} \quad \underline{\uparrow} \quad \underline{\uparrow} \quad \text{and} \quad \underline{\uparrow\downarrow} \quad \underline{\uparrow} \quad \underline{\quad}$
- (2 pts) M & T, 2-19 Provide explanations of the following phenomena:
  - The electron configuration of Cr is  $[Ar]4s^13d^5$  rather than  $[Ar]4s^23d^4$
  - The electron configuration of Ti is  $[Ar]4s^23d^2$  but  $Cr^{2+}$  is  $[Ar]3d^4$
- (4 pts) M & T, 2-25: Using Slater's rules, determine  $Z^*$  for:
  - a  $3p$  electron in P, S, Cl and Ar.  
Is the calculated  $Z^*$  consistent with the relative sizes of these atoms?
  - a  $2p$  electron in  $O^{2-}$ ,  $F^-$ ,  $Na^+$ , and  $Mg^{2+}$ .  
Is the calculated  $Z^*$  consistent with the relative sizes of these atoms?
  - a  $4s$  and  $3d$  electron of Cu.  
Which electron is more likely to be lost when copper forms a positive ion?
  - A  $4f$  electron in Ce, Pr, and Nd.  
The lanthanide contraction is a decrease in size with increasing atomic number in the lanthanides. Are your values consistent with this trend?