Chemistry 322
Inorganic Chemistry
Spring 2007

Take-Home Quiz 6 (Due at 11:59 pm on April 20th) – 16 points

Please answer the questions fully; use prose, calculations, figures and references as appropriate to communicate your understanding. The organization and comprehensibility of your answer is one basis for its evaluation. These questions are based on concepts discussed in Ch 8 and Ch 19 of Shriver & Atkins.

1. Give structures for:

   a) Triammineaquadichlorocobalt(III) chloride (all isomers)

   b) μ-oxo-bis[pentamminechromium(III)] ion

   c) Potassium diaquabis(oxalate)manganate(III)

2. Glycine has the structure NH_2CH_2COOH. It can lose a proton from the carboxyl group and form chelate rings bonded through the N and one of the O atoms. Draw structures for all possible isomers of tris(glycinato)cobalt(III). Don't forget enantiomers!

3. Name these:

   a) $[Cu(NH_3)_4]^{2+}$
   b) $[Mn(CN)_6]^{4-}$
   c) $[ReH_9]^{2-}$
   d) $[Ag(NH_3)_2][BF_4]$
   e) $[Co(en)_2CO_3]Br$
   f) $[Co(N_3)(NH_3)_5][SO_4]$

   (Notes: N_3^{1-} is azido; BF_4^{1-} is called tetrafluorborate)

4. When *cis*-OsO_2F_4 is dissolved in SbF_5, the cation $OsO_2F_3^+$ is formed. The ^{19}F NMR spectrum of this cation shows two resonances, a doublet and a triplet having relative intensities of 2:1. What is the most likely structure of this ion? What is its point group? (*Hints:* Fluorine is an NMR-active nucleus (I=1/2), and NMR spectra of fluorine atoms in molecules can be recorded in the same way as NMR spectra of protons are recorded. Fluorine NMR spectra show resonances and chemical shifts characteristic of the environment of the fluorine atoms. Everything you have learned about the relationship between the number of signals and the symmetry of the molecule is applicable to any type of NMR-active nucleus. Fluorine atoms split the signals of neighboring fluorine atoms in just the same way as protons split the signals of neighboring protons.)

(see back)

5. For the following complexes, draw a d orbital splitting diagram, fill in the appropriate number of d electrons, and calculate the total spin of the complex.

   a) $[Co(en)_3]^{2+}$, low spin

   b) $Fe(H_2O)_6^{3+}$, high spin

6. $[CuCl_5]^{3-}$ is a square pyramidal complex. Determine its point group symmetry and the transformation properties of the d orbitals on the copper ion. Using a crystal field approach (repulsion between metal and ligand electrons), decide on the energy ordering of the d orbitals and draw an energy level diagram (for the d orbitals only.) Briefly explain your reasoning for putting the orbitals in the order you chose.

7. One pink solid has the formula $CoCl_3 \cdot 5NH_3 \cdot H_2O$. A solution of this salt is also pink and rapidly gives three equivalents of AgCl on titration with $AgNO_3$ solution. When the pink solid is heated it loses one equivalent of water to give a second purple solid with the same ratio of NH_3:Cl:Co. The purple solid releases two of its chlorides rapidly; then on dissolution and after titration with silver nitrate releases one of its chlorides slowly. Deduce the structures of the two octahedral complexes (the pink solid and the purple solid) and draw and name them. Also, draw d orbital splitting diagrams for the two complexes qualitatively comparing the magnitude of Δ_o.

8. Do Exercise 8.13 in *Shriver & Atkins.*