CHEM. 341 (DR. AQUINO) TEST #2 NOVEMBER 23, 2010

Answer all questions in the booklets provided. Appropriate information and a periodic table are attached.

Question 1 - (14 marks, 2 marks each)

a) Determine the term symbols for states with the angular momentum and spin quantum numbers (*L*, *S*):

i) (5, 2) ii) (2, 3/2)

b) Order the following terms from *lowest* to *highest* energy:

i) ^{2}D, ^{2}F, ^{2}P, ^{2}G ii) ^{3}S, ^{4}P, ^{1}G, ^{2}F

c) Determine the ground-state terms for the following free ions or atoms:

i) Fe^{2+} ii) N^{3-} iii) Cl

Question 2 – (11 marks)

a) List ***all*** the d-electron configurations for *low-spin tetrahedral* complexes in which the Jahn-Teller effect is *theoretically* possible. (3 marks)

b) Name the following compounds (4 marks)

i) $NH_4[Ru(C_2O_4)_2(NH_3)_2]$ ii) $[Co(en)(H_2O)_2ClBr]I$

Give formulas for the following compounds (4 marks)

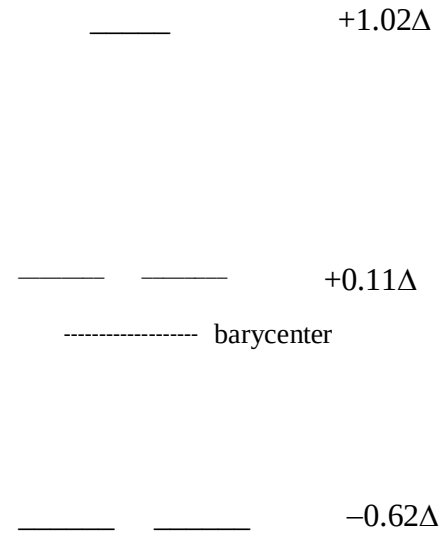
iii) triammineaquadichlorocobalt(III) chloride iv) sodium hexacyanoferrate(III)

Question 3 – (8 marks)

Briefly describe the NMR method of determining the magnetic susceptibility of a complex in solution. (less than 2 pages please)

Question 4 – (11 marks)

The splitting diagram for a linear (AB_2) ligand field is given below. (The z axis lies along the C_∞ axis of the molecule).



ALL OF THE FOLLOWING QUESTIONS REFER TO THIS SPLITTING DIAGRAM!!

a) Redraw the splitting diagram in your booklets and label the energy levels with the appropriate *d* orbitals. (5 marks)

b) A given linear AuL_2 complex containing Au^{3+} has a magnetic moment of 0.00 B.M. Calculate the ligand-field stabilization energy (LFSE) of this complex using the above splitting diagram. (4 marks)

c) What is the theoretical μ_{eff} (in BM) of a high-spin linear d^6 complex, using the above diagram? (2 marks)

Question 5 – (11 marks)

a) A solution of $[Ni(H_2O)_6]^{2+}$ is green and paramagnetic (μ_{eff} = 2.90 BM), whereas a solution of $[Ni(CN)_4]^{2-}$ is colourless and diamagnetic. Thoroughly explain these observations. (You may want to include diagrams showing the molecular geometry and the *d*-orbital energy levels of these complex ions as part of your answer). (6 marks)

b) A compound with the *empirical* formula $Fe(H_2O)_4(CN)_2$ has a magnetic moment corresponding to 8/3 unpaired electrons per iron. How is this possible? What is the actual *molecular* formula of this compound? (5 marks)