CHEM. 341 (DR. AQUINO) TEST #2 NOVEMBER 24, 2009

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

[15] - Question 1

a) Determine the possible microstates for a $2p^3$ electronic configuration and arrange them in a microstate table (M_L vs. M_S). (10 marks)

b) Determine the terms for the $2p^3$ configuration. (3 marks)

c) List the terms from *lowest* (ground state) to *highest* energy. (2 marks)

[10] - Question 2

Briefly describe the Guoy method of determining the magnetic susceptibility of a solid sample. (Include in your discussion how you would carry out the measurement, the instrumentation used, what data the measurement gives you and how the final result would help you in assessing the structure of your compound).

[12] - Question 3

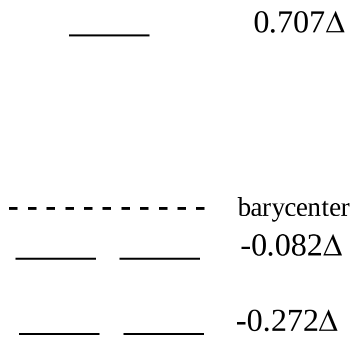
a) Give the *d electron configuration* and determine the *ground-state term* from the appropriate Tanabe-Sugano diagram for: i) high-spin $[Fe(H_2O)_6]^{3+}$ ii) $[V(H_2O)_6]^{2+}$ (4 marks)

b) While the Jahn-Teller effect is most often manifested in octahedral d^9 complexes it also occurs in some octahedral high-spin d^4 and octahedral low-spin d^7 compounds. Why? (4 marks)

c) The complex $[Ni(CN)_4]^{2-}$ is diamagnetic (μ_{eff} = 0 BM), but $[NiCl_4]^{2-}$ is paramagnetic with μ_{eff} = 2.9 BM. Draw the structures of these complexes and explain the magnetic properties in terms of ligand field theory (i.e. draw labeled splitting diagrams).

[14] - Question 4

The splitting diagram for a trigonal bipyramidal (tbp) crystal field is given below. (The z axis is coincident with the C_3 axis of the trigonal bipyramid).



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

b) Calculate the LFSE (in terms of Δ) for a d^3 (low-spin) and a d^7 (high-spin) *trigonal-bipyramidal* ion. (4 marks)

c) What is the theoretical μ_{eff} of a high-spin *trigonal-bipyramidal* d^6 complex. (2 marks)

d) If one of the axial ligands is removed to form a *trigonal-pyramidal* type structure how will the energies of *each of the orbital sets* listed in a) be effected? (i.e. will their energies increase, decrease, or stay the same?) (3 marks)

[9] - Question 5

a) The overall equilibrium constant (β_2) for the reaction of hexaaquocobalt(II) with 2 moles of acetate (CH_3COO^-) to form diacetatotetraaquocobalt(II) is 80, whereas that for the reaction with 1 mole of oxalate, $^-OOCCOO^-$ is 5×10^4. Write equations representing these reactions and briefly rationalize the differences in the magnitudes of the equilibrium constants. (6marks)

b) Using the data in a) determine an equilibrium constant for the following reaction:

$$[Co(CH_3COO)_2(H_2O)_4] \quad + \quad C_2O_4^{2-} \longrightarrow [Co(H_2O)_4(C_2O_4)] \quad + \quad 2CH_3COO^-$$

Is this reaction thermodynamically favourable? Explain. (3 marks)