CHEMISTRY 313

Test 1, Tuesday, September 29, 1998, 12:30 pm - 1:45 pm

(1.) (a) Please name 3 properties of atoms which change as you cross a period?
(b) Please draw the *d*-orbital splitting diagrams for $[FeCl_4]^-$ and $[RuCl_4]^-$. What are the theoretical magnetic moments for these ions?
(c) Please draw the molecule XeF_2 according to the shape predicted by VSEPR.
(d) For $POCl_3$, assume that a π-bond exists between P and O; what is the hybridization at O and at P? Please draw a diagram showing all the orbitals involved in the bonding between O and P.
(e) What fundamental property of the saline hydrides betrays their ionic nature? Why are the electropositive elements the only ones to form truly ionic hydrides?

(2.) (a) Please draw a Lewis structure of the molecule N_2O_4 (which has a formal single N-N bond) showing formal charges and possible resonance structures. What is the formal oxidation number of N? What is the occupancy at N? Please explain why there is not a double bond. The covalent radius of N is 0.72 Å; the actual N–N bond length in N_2O_4 is found to be 1.80 Å, however. Please consider the formal charges on each N in your explanation of why the single bond is so unexpectedly long.
(b) Please show the Lewis structures of the products of the heterolytic cleavage of the N-N bond in N_2O_4. Please show the shapes of these products.
(c) Please consider the information below to calculate the average N-O bond strength in N_2O_4

B(N=N) = + 946 kJ/mol
B(O-O) = + 146 kJ/mol
B(N-N) = + 160 kJ/mol
ΔH_f^0 N_2O_4 (g) = + 9.2 kJ/mol

(d) Please assign oxidation numbers for *all* atoms in the following species: HF_2^-, NF_4^+, UO_5^{4-}, N_2H_2, O_2F_2 (peroxide-type structure)
(e) Please give the short-hand ground-state electronic configurations of: Ni^{3+}, Mo^{5+}, Gd^{3+}, Rb^-, Xe^+.
(f) Please predict which will be the cathode and anode in a galvanic cell composed from the following standard electrode reactions:

Pt^{2+} (aq) + $2e^-$ Pt (s) $\quad E^0 = +1.20$ V

Ag^+ (aq) + e^- Ag (s) $\quad E^0 = +0.80$ V

What will be the cell potential under standard conditions?
What is the standard free energy of the cell in kJ? (volts = joules/coulombs)
Please write the short-hand notation for the galvanic cell.
What would be the cell potential if [Ag^+ (aq)]= 0.025 M, and [Pt^{2+} (aq)]= 0.160 M?
What is the cell potential at equilibrium?