Chemistry 101 Final Exam Guide (DO NOT LIMIT YOUR REVIEW TO THESE QUESTIONS!)
The 200 pt test is on Friday, March 16, 2007 at 8-10:30 am. The final exam is cumulative and will assume you have reviewed chapters 1-8 with greater emphasis placed on material starting with chapter 6.

Chapter 6: Thermochemistry
a) Be able to state and to apply the first law of thermodynamics.
b) Calculate enthalpy and energy using constant pressure and constant volume calorimetry.
c) Do calculations using Hess'Law and $H_f°$'s on problems resembling the questions at the end of the experiments on calorimetry (see lab manual for these questions). KNOW these VERY WELL.
d) calculate heat changes for a substance undergoing heating both with and without phase.
Chapt 7. Quantum Theory:
a) Do calculations involving photon energy, frequency and wavelength for electromagnetic radiation.
b) Do calculations involving the energy levels of the hydrogen atom. What is the Balmer series and how is it different from the other series?
c) Know the rules for allowable quantum numbers of the electron's wave function.
d) Be able to write the electron configuration of elements and their ions.(also using core notation).
e) Be able to explain the periodic trends of: atomic radii, ionic radii, electron affinity and ionization potential
Chapt 8. Covalent Bonding:
a) Be able to draw the Lewis structure for a molecule. Know the rules for drawing Lewis structures.
b) Know the various types of isomers possible.
c) use bond enthalpies to determine the enthalpy of reaction.
d) know how to determine formal charge to differentiate between possible Lewis structures.
e) Know: resonance, octet rule.

We'll include molecular orbital theory this quarter.

Below are some practice review question. Be able to do all homework in chapt 8.

1) An acidic compound composed of 2.1%H, 29.8% N and 68.1% O has a molecular mass of 47 g/mol.a) What is the empirical formula of the compound? b) What is the name of the compound? c) What is the Lewis structure if H is bonded to O? d) What is the electron domain geometry around N? e) What is the molecular geometry of the molecule (describe all angles)? f) Give the formal charge of nitrogen and oxygen in the molecule. g) Predict the polar/nonpolar nature of this molecule? h) What are the hybrid orbitals present in the N atom? in the O atom?
Assume 100 g, determine 3 moles of each element and determine the formula from there.
#mol H = 2.1/1=2.1mol, # mol N = 29.8/14.0=2.13; #mol O = 68.1/16=4.25. divide by lowest #
mol H=1, N =1, O=2: HNO_2 Nitrous acid; c) lewis struc d) trig planar, e)

bent, 120°, f) –1 for O; g) polar h) ignore hybrids orbitals.

2) Explain the periodic trends: atomic radii, ionization energy, electron affinity. Explain “anomalies” in the ionization energy trend involving 2^{nd} row elements.

Refer to text.Note that for example, O has a lower ionization energy than N (unexpected if you only rely on the trend) because N has three 2p valence electrons each of which occupy a single orbital whereas O has four 2p valence electrons, two of which occupy the same orbital. This introduces another factor: electron pair repulsion – which makes the removal of the first electron from oxygen easier than that of N and therefore, N has a lower ionization energy than N.

3) a) Using "box" notation, draw the occupied orbitals of neutral vanadium. How many unpaired electrons is in V? b) Explain why nitrogen has a higher first ionization energy than oxygen. Explain why it has a higher first ionization energy than carbon.

4) **Periodic trends:** Arrange following in order of a) increasing size:Ar, S^{2-}, K^{2+} , They are isoelectronic: so K^{2+}, Ar, S^{2-}

b) increasing ionization energy: F, S, Al, He Al, S, F, He

c) increasing electronegativity: Se, Ne, O Se. O, Ne

d) molecular polarity: H_2O, CO_2, NO_2^- CO_2, NO_2^-, H_2O

5) Consider the following molecules, and fill in the information requested below each molecular formula:(note that some may violate the octet rule) H_2O, XeF_4, PCl_5, SO_4^{2-}

here draw the Lewis structures.

6) Write down the electron configurations of Li_2, O_2, N_2 in terms of its MOs (molecular orbitals). Compare their bond orders and predict their magnetic properties. Write down their Lewis structures.

MO theory is included. Li_2 : $(\sigma_{2s})^2$; O_2 : $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma_{2p})^2(\pi_{2p})^4(\pi_{2p}^*)^2$; N_2: $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma_{2p})^2(\pi_{2p})^4$ only O_2 is paramagnetic due to the presence of unpaired electrons in the π_{2p}^* orbital.

7) Consider the reaction of oxalic acid ($H_2C_2O_4$) with nitrous acid (HNO_2) to form carbon dioxide gas, nitrogen monoxide, and water. a) write the balanced equation. b) what type of reactions is this? If redox, identify the reducing and oxidizing agent. c) Determine the oxidation numbers of all elements involved.

a) $H_2C_2O_4 + 2HNO_2 \rightarrow 2\ CO_2 + 2\ NO + 2\ H_2O$ b) redox reaction. oxidant is HNO_3 and reductant is $H_2C_2O_4$. c) Ox #’s: C is +3 in $H_2C_2O_4$ and is +4 in CO_2 . N is +3 in HNO_2 and +2 in NO.

8) Describe or explain scientic contributions made by Dalton, Mendeleev, Planck, Einstein, Thomson, Bohr, Schrodinger, de Broglie & Heisenberg in our modern understanding of the atom. What is the wavelength of a proton ($1.67\text{x}10^{-27}$ kg) travelling at $1.2\text{x}10^5$m/s?

$\lambda = h/mv = 6.63 \times 10^{-34}$ Js/($1.67\text{x}10^{-27}$kg ($1.\text{x}10^5$m/s)= 3.3×10^{-12} = .033Å

9) The energy required to convert O_2 molecules to O atoms is 496 kJ/mol. If electronic radiation of 180 nm is absorbed by 1 mole of O_2 molecules, how much kinetic energy will be present in the O atoms? What wavelength photons are required to "split" O_2 molecules to O atoms?

Solution: $E_{photon} = hc/\lambda = (6.63 \times 10^{-34}\ Js)(3 \times 10^{8} m/s)/(180 \times 10^{-9} m) = 0.111 \times 10^{-17} J$ Therefore, per mole of photons: $E_{photons} = 0.67 \times 10^{5} J = 670\ kJ/mol$. the KE of the atoms after being dissociated, will be 670 kJ – 496 kj/mol =169 kJ/mol or $2.81 \times 10^{-19} J/mol$.

10) a) Name the following when pure and when in an aqueous solution:i) $HClO_3$, ii) $HClO_2$, & iii) H_2S :

b) Name the compounds: K_3PO_4 ; $BaCl_2$; Give the formulas for aluminum dichromate, magnesium phosphate

do this in class

11) Give the number of electrons, protons and neutrons in: ferrous ion; mercuric ion or $^{195}_{78}Pt^{4+}$.. Write down the corresponding electron configurations for these ions.

#p=78, #n=195-78=117, #e =78-4=74

12). The density of a hydrochloric acid (HCl) solution is 1.19 g/mL. If its concentration is 37% (mass percent). How many mLs of the solution would contain 3.01×10^{22} molecules of hydrogen chloride?

#mL =3.01E22x(1mol/6.02E23)(36.5g/mol)(100mL/37g)(1mL/1.19g)=4.14 mL

13) Lithium metal has a higher activity than hydrogen.a) Will adding Li metal to acid lead to a reaction? If so, write a balanced equation for the reaction of Li with acid. If 2.00 g lithium is added to 5.00 g water, what volume (in liters) of hydrogen gas will be formed if the %yield is 76%? (note:density, $\rho(H_2(g))$ = 0.0893 g/L). What is the limiting reagent?

Li has higher tendency to oxidize so $2Li + 2H^+ \rightarrow 2Li^+ + H_2(g)$.

Assuming Li is limiting, we have:

#L H_2 = 2.00g Li x(1mol/6g)(1 molH_2/2 mol Li) (2g/mol)(1L/.0893g)=3.7

Assuming H_2O is limiting, we have:

#L H_2 = 5.00g H_2Ox(1mol/18g) 1mol H_2/molH_2O)(2g/mol)(1L/.0893g)=6.2L

therefore Li is limiting. If the yield is 76%, then the #L H_2gas = 3.7 L (.76)=2.8 L

14) Consider the reaction of iron(II) chloride with potassium permanganate in an acidic solution. The balanced net ionic equation is given below:$5\ Fe^{2+}(aq) + MnO_4^-(aq) + 8H^+(aq) \longrightarrow 5\ Fe^{3+}(aq) + Mn^{2+}(aq) + 4\ H_2O$

a) Suppose you titrate 35.0 mLs of iron(II) chloride solution with 0.0500 M potassium permanganate, and the equivalence point is reached at 24.0 mLs, what is the original concentration of the iron(II) chloride solution?

b) What is the concentration of the iron(II) chloride in the solution 10.0 mLs <u>before</u> the equivalence point?

a) [$FeCl_2$] = 24.0 mL(.0500mol $KMnO_4$)/1L x (5 mol Fe/mol MnO_4)/(35.0mL)=0.17 M

b) [$FeCl_2$] = {(35.0mL)(.17M) – (24.0-10.0mL)(.0500M)(5mol Fe/mol MnO_4)}/(24.0+25.0)

= (5.95 - 3.5)/49 = 0.050M