Chemistry 101 Final Exam Guide (DO NOT LIMIT YOUR REVIEW TO THESE QUESTIONS!)
The 200 pt test is on Monday, March 14, 2005 at 8-10:30 am. The final exam is cumulative and will assume you have reviewed chapters 1-8 with great emphasis placed on material after chapter 5.

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 Lyman and Paschen 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 only if we get to it in the lecture. If we don't then we'll take it up next quarter.

Below are some practice review question. Be able to do <u>all</u> 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?Assume 100g: 2.1/1=2.2 molH;N:29.8/14=2.12molN ; O:68.1/16=4.26molO; divide all by 2.1: HNO_2.
b) What is the name of the compound? Hydrogen nitrite (nitrous acid)
c) What is the Lewis structure if H is bonded to O? H-O-N=O::
d) Give the formal charge of nitrogen and oxygen in the molecule. N:FC=5-5; O:6-6; both.

2) Explain the periodic trends: atomic radii, ionization energy, electron affinity. Explain "anomalies" in the ionization energy trend involving 2nd row elements. Radii increase to left and down. IE increase to right and up. EA increases to up and right but not including group8. Anomaly is due to subshells filling up. Li is $2s^1$; Be $2s^2$; B: $2s^22p^1$; C $2s^22p^2$; N $2s^22p^3$; O $2s^22p^4$; F: $2s^2p^5$; Ne: $2s^22p^6$. easier to remove e from B than from Be. Easier to remove e from O than from N.

3) a) Using "box" notation, draw the occupied orbitals of neutral vanadium. $_{23}V: 1s^22s^22p^63s^23p^64s^23d^3$. How many unpaired electrons is in V? . there are 3 unpaired e's. b) Explain why nitrogen has a higher first ionization energy than oxygen. Easier to remove e from O than from N. Explain why it has a higher first ionization energy than carbon. Easier to remove e from C than from N because N has a higher Z_{eff}.

4) Periodic trends: Arrange following in order of a) increasing size:Ar, S^{2-}, K^{2+} , K^{2+},Ar, S^{2-},
b) increasing ionization energy: F, S, Al, He Al S F He
c) increasing electronegativity: Se, Ne, O Se, Ne, O
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-} Lewis structure.
6) MO theory: Write down the molecular orbital electron configurations (ie. If we get to it) 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. Li_2"
$1\sigma_{1s}^2 1\sigma_{1s}^{*2} 2\sigma_{2s}^2$;
O_2: $1\sigma_{1s}^2 1\sigma_{1s}^{*2} 2\sigma_{2s}^2 2\sigma_{2s}^{*2} 2\pi_{2p}^4 2\sigma_{2p}^2 2\pi_{2p}^{*2}$
N_2: $1\sigma_{1s}^2 1\sigma_{1s}^{*2} 2\sigma_{2s}^2 2\sigma_{2s}^{*2} 2\pi_{2p}^4 2\sigma_{2p}^2$

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. $H_2C_2O_4 + 2\ HNO_2 \rightarrow 2\ CO_2 + 2\ NO + 2\ H_2O$
+3 +3 +4 +2
b) What type of reactions is this? Redox
If redox, identify the reducing and oxidizing agent. Oxidizing agt:HNO_2. reducer: $C_2O_4^{2-}$
c) Determine the oxidation numbers of all elements involved. See up.

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 (1.67×10^{-27} kg) travelling at 1.2×10^5m/s?
read your book. $\lambda = h/mu = (6.63\times10^{-34}Js)/((1.67\times10^{-27}kg)(1.2\times10^5m/s)) = 3.3\times10^{-12}m$

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?
Energy required to convert O_2 is $496x10^3 J/6.02x10^{23} molecs = 8.2x10^{-19} J/molec.$
$\lambda = hc/E = (6.63x10^{-34} Js)(3x10^8 m)/(8.2x10^{-19} J) = 2.42x10^{-7} m = 242$ nm.
180 nm has more energy than 242 nm so it will split the O_2 molecs. The excess energy will be converted into kinetic energy of the O_2 molecules. $E_{180nm} = hc/\lambda = 6.63x10^{-34}(3x10^8)/(180x10^{-9}) = .111x10^{-17} = 11.1x10^{-19}$nm.
So the extra energy (converted to KE) will be 11.1-8.2 = 2.9 x 10^{-19} J.

10) a) Name the following when pure and when in an aqueous solution:i) $HClO_3$, hydrogen chlorate; chloric acid. ii) $HClO_2$, hydrogen chlorite; chlorous acid. & iii) H_2S hydrogen sulfide, hydrosulfuric acid:
b) Name the compounds: K_3PO_4 ; $BaCl_2$; Give the formulas for aluminum dichromate, magnesium phosphate

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.
$_{26}Fe^{2+}$ ([Ar] 3d8; $_{80}Hg^{2+}$: $[_{54}Xe]$ ~~$6s^2$~~ $4f^{14}$ $5d^{10}$; $^{195}_{78}Pt^{4+}$:$[_{54}Xe]$ ~~$6s^2$~~ $4f^{14}$ $5d^6$

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 x 10^{22} molecules of hydrogen chloride?
[HCl] = (370g HCl/1000g soln)(1.19g/mL)(1mol/35.54g)=12.4M

15) Lithium metal has a higher activity than hydrogen.
a) Will adding Li metal to acid lead to a reaction? Yes. $Li \rightarrow Li^+ + e$ will oxidize while H^+ will reduce to H_2
If so, write a balanced equation for the reaction of Li with acid. $Li(s) + H^+(aq) \rightarrow Li^+(aq) + 1/2\ H_2(g)$.
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).
Need to edit this question so it is doable within the context of our chapters so far:
Use: $2\ Li + H_2O \rightarrow Li_2O + H_2$.
mol Li = 2.0g/6.94g = 0.288 mol Li, mol H_2O = 5.00g/18.0=0.277. Li is limiting since you would need only : #mol H_2O needed = .288 mol Li (1mol H_2O/2 mol Li) = 0.144 mol H_2O.
ok. So #L H_2 = .288 mol Li x (1 mol H_2/2 mol Li)(2.0 g H_2/mol H_2)(1L/.0893g H_2) = 3.22L

What is the limiting reagent? Li is limiting since you would need only : #mol H_2O needed = .288 mol Li (1mol H_2O/2 mol Li) = 0.144 mol H_2O.

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

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?

OK. The product containing Mn should have been given at least for the purposes of this class. The reaction is: $Fe^{2+} + MnO_4^- \rightarrow Fe^{3+} + Mn^{2+}$. Need to balance it. Express in terms of half reactions.

(1) $Fe^{2+} \rightarrow Fe^{3+} + e^-$ and (2) $8H^+ + MnO_4^- + 5e^- \rightarrow Mn^{2+} + 4H_2O$

+7 +2

OK, let's add them: 5x(1) + (2) : $5Fe^{2+} + 8H^+ + MnO_4^- \rightarrow 5\ Fe^{3+} + Mn^{2+} + 4\ H_2O$

$[Fe^{2+}]$ = mol Fe^{2+}/L Fe^{2+} = (0.0500 M MnO_4^-)(.0240 L MnO_4^-)(5 mol Fe/1 mol MnO_4^-)/(.0350L)=0.171M

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

$[Fe^{2+}]$ = mol Fe^{2+}/L Fe^{2+} = (0.0500 M MnO_4^-)(14mL MnO_4^-)(5 mol Fe/1 mol MnO_4^-)/(35+14mL)=0.0174M

17) A 195 nm wavelength photon of ultraviolet radiation is observed to eject electrons from a certain metal surface by the photoelectric effect. If the maximum kinetic energy of the ejected electrons is 3.7×10^{-19}J, what is the *work function* of this metal? Is the work function the same as the first ionization energy? Explain.

First get energy of the 195nm: $E = hc/\lambda = (6.63\times10^{-34})(3\times10^{8})/(195\times10^{-9}) = 10.2\times10^{-19}$J

OK, compare this with the $KE_{max} = 3.7\times10^{-19}$J.

the work function is the difference: 10.2×10^{-19}J $- 3.7\times10^{-19}$J $= 6.5\times10^{-19}$J

The work function is not the same as the ionization energy. The IE is the energy required to remove an e from an atom in the gaseous state not the solid state.