University of Windsor
Chemistry and Biochemistry
Chemistry 59-250, Fall Term 2005

Assignment 1

I will provide the answers for these questions in around one week and we can look at how the questions are done in tutorial.

Question #1
Oxidation States and RedOx Chemistry

Use the oxidation state (Frost) diagram I provided in class to determine whether the following redox reactions will proceed and, if so, the oxidation states of the products. All reactions are in acidic conditions ([H+] = 1) and there is no need to balance the equations.

(i) $Cl_2 + H_2O \rightarrow$

(ii) MnO_2 + oxalic acid $\rightarrow$

(iii) Cu(+1) + acid $\rightarrow$

(iv) Fe(+3) + Cr(+2) $\rightarrow$

(v) calcium metal + oxalic acid $\rightarrow$

Identify the oxidation state of each atom in the following equations and balance the equations:

$$Cu + HNO_3 \rightarrow Cu(NO_3)_2 + NO + H_2O$$

$$PO_3^{-3} + MnO_4^- + H^+ \rightarrow Mn(+2) + PO_4^{-3} + H_2O$$

$Fe(+2) + MnO_4^- + H^+ \rightarrow Mn(+2) + Fe(+3) + H_2O$

Question #2
Quantum Numbers and Drawing Orbitals

Provide appropriate quantum numbers for an electron in the following orbitals:

(i) 4s

(ii) $5p_x$

(iii) $4d_{z^2}$

(iv) $3d_{x^2-y^2}$

Draw reasonable plots (function vs. r) of the radial functions Ψ, Ψ^2 and $4\pi r^2\Psi^2$ for a 4s orbital.

Draw reasonable representations, indicating their three-dimensional nature as best you can, of the following orbitals [specify the direction of the axes used and include sign of the phase (+ or -) of each lobe]:

(i) $3d_{z^2}$

(ii) $2p_x$

(iii) $4d_{xz}$

Question #3

Energy Level Diagrams and the Bohr Equation

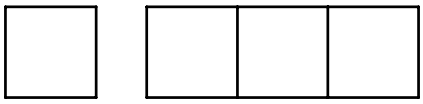
Use the Bohr equation (ignore the correction for effective nuclear charge) to construct an energy level diagram for **boron**. Determine the energies for the first 4 shells and for n = ∞, label all subshells and don't forget to include the electrons.

Question #4

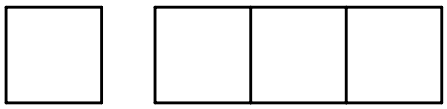
Electron Configurations, Ground States, Excited States and Forbidden States

(i) Write the complete electron configuration for the ground state of gallium.

(ii) An "excited state" of an atom has a higher energy configuration than the ground state configuration. Put electrons in the valence orbitals (i.e. boxes) below to give an excited state electron configuration for gallium.



(iii) A "forbidden state" of an atom has a hypothetical electron configuration that defies at least one of the rules we have discussed regarding allowed quantum numbers. Put electrons in the valence orbitals (i.e. boxes) below to give a forbidden electron configuration for gallium.



Question #5

Slater's Rules and Ionization Energies

Use Slater's rules to calculate σ, Z^* and the first ionization energy for **three** of the elements in group 14. Please show your calculations (that's the important part) and remember that the first ionization energy is found by the equation IP = 13.6 ($Z^{*2}/\mathbf{n}^2$). Compare your calculated ionization energies to the experimental values that I provided in class - is this method accurate for such predictions? Use the back of this page if extra space is required.