The University of Western Ontario
Department of Physics and Astronomy

P2800 Fall 2008

Homework Assignment #1 (September 11, 2008)

Due date: September 23, 2008

Problems:

1. An alloy consist of 80 weight % Cu and 20 weight % Be. What are the atomic percentages of Cu and Be in the alloy? (1.5 points)

Assume alloy of 100g: 20g Be (A.W.$_{Be}$=9.012g/mol) and 80g of Cu (A.W.$_{Cu}$=63.546g/mol)

$$Cu,\% = \frac{\frac{80}{63.546}}{\left(\frac{80}{63.546}+\frac{20}{9.012}\right)}\times 100\% = 36.20\%$$

$$Be,\% = \frac{\frac{20}{9.012}}{\left(\frac{80}{63.546}+\frac{20}{9.012}\right)}\times 100\% = 63.80\%$$

2. Calculate the energy in joules and electron volts of the photon whose wavelength is 226.4nm. (1 point)

$$\Delta E = \frac{hc}{\lambda} = \frac{(6.63\times 10^{-34} Js)(3.00\times 10^{8} m/s)}{(226.4nm)(10^{-9} m/nm)} = 8.79\times 10^{-19} J = 8.79\times 10^{-19} J\left[\frac{1eV}{1.60\times 10^{-19} J}\right] = 5.5eV$$

3. Electronic configuration of chlorine is $1s^2 2s^2 p^6 3s^2 p^5$. Using the table of electronegativity (see lecture notes) and assuming that the full electron transfer occurs from less electronegative to more electronegative element:

(a) determine the oxidation number of chlorine in the compounds in the table;

(b) write the electron configuration of the chlorine ions using *spdf* notation (1.5 point).

Compound	Cl oxidation number	Cl ion electron configuration
KCl	-1	$1s^2 2s^2 p^6 3s^2 p^6$
KClO	+1	$1s^2 2s^2 p^6 3s^2 p^4$
$KClO_2$	+3	$1s^2 2s^2 p^6 3s^2 p^2$
$KClO_3$	+5	$1s^2 2s^2 p^6 3s^2$
$KClO_4$	+7	$1s^2 2s^2 p^6$

4. Calculate the attractive force between a pair of K+ and Br- ions that are located on equilibrium distance between each other. Assume the ionic radius of the K+ ion to be 0.133nm and that of the Br- ion to be 0.196nm. (1.5 points)

The attractive force between the ion pair is found by applying Coulomb's law

$$F_{ATTR} = \frac{-Z_1 Z_2 e^2}{4\pi\varepsilon_0 a_0^2}; \text{ where } Z_1 = +1 \text{ for } K^+, Z_2 = -1 \text{ for } Br^-, \text{ and } a_0 = r_{K+} + r_{Br-} =$$

$$= 0.133nm + 0.196nm = 0.329nm = 3.29\times10^{-10} m$$

$$F_{ATTR} = \frac{-(+1)(-1)(1.6\times10^{-19}C)^2}{4\pi(8.85\times10^{-12}C^2/Nm^2)(3.29\times10^{-10}m)^2} = 2.13\times10^{-9} N$$

5. Predict a predominant (and, if applicable, secondary) bonding type in the compound X-Y, where electronic configuration for X and Y in their neutral states are listed below. Identify the elements and suggest stoichiometry, whenever appropriate (2 points):

a) X=Y: $[Ar]4s^2 3d^8$;		X=Y=Ni	metallic
b) X: $[Kr]5s^2 4d^2$;	Y: $[He]2s^2 2p^4$;	ZrO	ionic
c) X=Y: $[He]2s^2 2p^2$;		C(diamond-covalent; graphite, fullerene-covalent and vdW)	
d) X=Y: $[Ar]4s^2 3d^{10} 4p^6$;		Kr	fluctuating dipole
e) X: $[Ne]3s^2 3p^2$;	Y: $[He]2s^2 2p^2$;	SiC	covalent
f) X: $[He]2s^2 2p^3$;	Y: $[He]2s^2 2p^4$;	NO	covalent, permanent dipole
g) X: $[Ar]4s^2 3d^6$;	Y: $[He]2s^2 2p^4$;	FeO	ionic;
h) X: $[Ne]3s^2$;	Y: $[He]2s^2 2p^4$;	MgO	ionic
i) X: $1s^2$;	Y: $[He]2s^2 2p^5$;	HeF	fluctuating dipole
j) X=Y: $[He]2s^2 2p^5$		F_2	covalent

6. Compare the percentage ionic character in the semiconducting compound InSb amd ZnTe. (1.5 points)

same: $\%\text{Ionic character} = 100\% \times (1 - \exp^{-0.25(1.5-1.8)^2}) = 2.2\%$

7. Methane (CH_4) has a much lower boiling temperature than does water (H_2O). Explain why this is true in terms of the bonding **between molecules** in each of these two substances (1 point).

The methane molecules are bonded together by weak –C-H dipoles. The water molecules are bonded together by the much stronger –O-H hydrogen dipoles.