Inorganic Cumulative Exam

Prof. B. K. Teo, April 7, 2005

Total 6 Qs, 115 points.

1. (30%) Count electrons, predict the structures, and give the point-group symmetries of $[P_7]^{3-}$ and P_4S_3:

(a) Skeletal electron pairs.

(b) Structures.

(c) Point group symmetries.

2. (27%) Give the structures, the number of skeletal electron pairs, and the point-group symmetries of each of the following clusters and show how they are related and/or can be interconverted:

(a) trigonal bipyramid, square pyramid, arachno-pentagonal bipyramid.

(b) $B_9H_{11,}$ $B_8H_{12,}$ B_7H_{13}.

(c) $Os_7(CO)_{21}$, $[Os_8(CO)_{22}]^{2-}$, $[Os_{10}C(CO)_{24}]^{2-}$.

3. (10%) H_2SO_3 is known to exist in two isomers. What would the structures and the pK_a values be for the corresponding H_2SO_3 ?

4. (20%) Using ligand field theory, explain why:

(a) $[NiCl_4]^{2-}$ is paramagnetic while $[Ni(CN)_4]^{2-}$ is diamagnetic.

(b) $NiCl_2(PPh_3)_2$ is paramagnetic while $PdCl_2(PPh_3)_2$ is diamagnetic.

5. (8%) For the following list of compounds, indicate:

$[Mn(CO)_6]^+$, $[V(CO)_6]^-$, $Ni(CO)_4$, $[Fe(CO)_4]^{2-}$, $[Mn(CN)_6]^{4-}$, $[Fe(CN)_6]^{3-}$, $[Fe(CN)_6]^{4-}$

(a) The highest CO stretching frequency.

(b) The lowest CO stretching frequency.

(c) The highest CN stretching frequency.

(d) The lowest CN stretching frequency.

6. (20%) Extremely potent acids, capable of protonating even hydrocarbons, are called *superacids*. Examples are mixtures of the following:

(a) $2HF + SbF_5 = [H_2F]^+ + [SbF_6]^-$

(b) $2HSO_3F + SbF_5 = [H_2SO_3F]^+ + [F_5SbOSO_2F]^-$

Draw the structures of all the products and identify the superacids.