INORGANIC CHEMISTRY - 1ST HOURLY EXAM

October 6, 1997

Name _____

1. Give the correct electron configuration for the following atoms and ions. [30 pts]

A.) Zn^{2+} _____
B.) Te _____
C.) Cu^{2+} _____
D.)Mo _____
E.) As^{3-} _____

2. For the following molecules and ions, [50 pts]

i) Write the correct Lewis structure showing all formal charges
ii) Sketch and identify the correct molecular geometry. Determine all "idealized" bond angles
iii) Determine the idealized hybridization of all sigma bonding orbitals on the central atom
iv) Determine the correct point group of the idealized molecular geometry

A.) OCN^-

B.) SeF_4

C.) PCl_4^+

D.) SiF_6^{2-}

3. The square planar molecule, XeF_4, belongs to the point group D_{4h} . A character table is given below.

D_{4h}	E	$2C_4$	C_2	$2C_2'$	$2C_2''$	i	$2S_4$	σ_h	$2\sigma_v$	$2\sigma_d$		
A_{1g}	1	1	1	1	1	1	1	1	1	1		$x^2 + y^2, z^2$
A_{2g}	1	1	1	−1	−1	1	1	1	−1	−1	R_z	
B_{1g}	1	−1	1	1	−1	1	−1	1	1	−1		$x^2 - y^2$
B_{2g}	1	−1	1	−1	1	1	−1	1	−1	1		xy
E_g	2	0	−2	0	0	2	0	−2	0	0	(R_x, R_y)	(xz, yz)
A_{1u}	1	1	1	1	1	−1	−1	−1	−1	−1		
A_{2u}	1	1	1	−1	−1	−1	−1	−1	1	1	z	
B_{1u}	1	−1	1	1	−1	−1	1	−1	−1	1		
B_{2u}	1	−1	1	−1	1	−1	1	−1	1	−1		
E_u	2	0	−2	0	0	−2	0	2	0	0	(x, y)	

a) Sketch the structure of XeF_4 and show all symmetry elements associated with the molecule (including improper axes) [15 pts]

b)What is the order of the group D_{4h}? [5 pts]

c) Determine which irreducible representation each of the following atomic orbitals on xenon belong. [10 pts]

s _____
p_x _____
p_y _____
p_z _____

d_{xy} _____
d_{xz} _____
d_{yz} _____
d_{z2} _____
d_{x2-y2} _____

d) The four sigma bonding orbitals from fluorine form three symmetry adapted linear combinations (SALC's): A_{1g}, B_{1g}, and E_u. Draw a qualitative molecular orbital diagram showing the interaction of fluorine SALC's with the xenon atomic orbitals. (Hint: If more than one atomic orbital on xenon can interact with any particular fluorine SALC, then the order of preference is s>p>d.). [15 pts]

4. The following questions pertain to periodic properties of the elements. [35 pts]

A) The atom or ion with the smallest radius. (K^+, S^{2-}, Ar, Cl^-). _____

B) The atom or ion with the greatest ionization potential. (P, Cl, N, O) _____

C) The atom or ion with the greatest electron affinity. (P, Cl, N, O) _____

D) The most electronegative element. _____

E) The element with the greatest Z_{eff}. (Si, Ge, Sn, Pb) _____

F) The element with the greatest bond strength with hydrogen (N, P, As, Sb) _____

G) The element woth the greatest bond strength to fluorine (N, P, As, Sb) _____

5. The following questions pertain to the trigonal bipyramid geometry.

A.)Electronegative substituents prefer apical positions in the trigonal bipyramid geometry. Explain why this is the case. [20 pts]

B.) Trigonal bipyramidal molecules such as PF_5 and $Fe(CO)_5$ commonly display non-rigid stereochemistry. Using PF_5 as an example, a) explain what is meant by non-rigid stereochemistry and b) show the mechanism (Berry pseudorotation) by which PF_5 exhibits non-rigid stereochemical behavior. [20 pts]