***CHEMISTRY 362***

# *Descriptive Inorganic Chemistry*

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Examination I

February 15, 2019

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**An Aggie does not lie, cheat or steal or tolerate those who do.**

**Useful formula:** μs.o. =

***See last page for Slater’s Rules and Point Group Flow Chart***

**Useless Conversion Factors**

Ratio of an igloo's circumference to its diameter: Eskimo Pi

2000 pounds of Chinese soup: Won ton

1 millionth of a mouthwash: 1 microscope

Time between slipping on a peel and smacking the pavement: 1 bananosecond

1. Formulae and other matches:

|  |  |  |
| --- | --- | --- |
|  | **List 1** | **List 2** |
| \_\_\_\_\_\_\_ | # angular nodes | 1. F = -1 |
| \_\_\_\_\_\_\_ | Dipole moment | 1. Z - Zeff |
| \_\_\_\_\_\_\_ | Screening constant | 1. A  IEA + EAA |
| \_\_\_\_\_\_\_ | H-like ions | 1. mv = h/λ |
| \_\_\_\_\_\_\_ | Magnetic moment (spin only) |  |
| \_\_\_\_\_\_\_ | Spin multiplicity | 1. n – l - 1 |
| \_\_\_\_\_\_\_ | de Broglie | 1. Hψ = Eψ |
| \_\_\_\_\_\_\_ | Schrodinger | 1. Q x r (Q = charge; r = distance) |
| \_\_\_\_\_\_\_ | For A-B  Pauling electronegativity | 1. 2S + 1 |
| \_\_\_\_\_\_\_ | For A-B  Mulliken electronegativity |  |
|  |  |  |
| \_\_\_\_\_\_\_ | Oxidation state  # radial nodes | l) l |
|  |  |  |

1. **Circle the correct answer:**
2. The orbital with two radial and one angular nodes

a) 4s b) 4p c) 4d d) 4f

1. The orbital with greatest angular momentum

a) 4s b) 4p c) 4d d) 4f

1. The atom of highest ionization energy

a) Zn0 b) Ca0 c) Cu0 d) Fe0

1. The atom of highest electron affinity energy (E + e**−** -> E**−**)

C0 Na0 Cl0 B0

1. The largest radius belongs to

Ne0 F0 Cl0 Cl**−**

1. Species of smallest H-E-H angle

NH3 PH3 H2O BH3

1. A molecule that is *not* paramagnetic

NO O2 H2O2 O2-

1. Molecule that displays hypervalency

BF3 NF3 SiF4 SF4

1. Molecule that displays hypovalency

BF3 NF3 SiF4 SF4

1. The orbital that contains the lone pair in NH3

a) the 2s orbital on N; b) the 2p orbital on N;

c) an sp3 hybrid of more s character than p; d) an sp3 hybrid of more p character than s

1. The formal charges on Oa, S, Ob in SO2 for the resonance form:

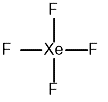
a) 0, 0, 0 b) -2, +2, -2 c) -1, +1, -2 d) 0, +1, -1

1. The spin only magnetic moment of gaseous Mn2+(g).

a) 1.73 b) 2.83 c) 5.92 d) 3.88

1. **Quantum numbers, orbital contours:**
2. What are the quantum numbers (n, l, ml, ms) for the last electron added into the d orbitals of a Ni0 atom? (Hint: Use the box diagram approach to get your bearings.)
3. On the following coordinate axes, sketch the contours or the orbitals indicated.   
   Give signs of the lobes.

|  |  |  |
| --- | --- | --- |
| 1. pz orbital   Z  X  Y | 1. b) bbbbb) h b) the dyz orbital   Z  X  Y | 1. A hybrid comprised of   1/3 s + 2/3 (px + py)  Z  X  Y |

1. According to Slater, why should the experimentally observed electronic configuration of K0, 1s22s22p63s23p64s1, be the ground state rather than the excited state configuration 1s22s22p63s23p63d1?
2. Give the term symbols that describe the ground and the excited states of K0 as described in part 4 above. Calculate the spin only magnetic moment for both.
3. Question III relates to XeF4, shown right (with the unique Z axis coming out of the paper plane towards you). In 1-5 circle the correct answer.

1. The number of lone pairs on Xe in XeF4 : 1 2 4 5

2. The oxidation state of Xe in XeF4 : 0 2 4 6

3. The number of mirror planes in XeF4 : 1 2 4 5

4. The principal (highest order) rotation axis in XeF4: C4 C2 C3 C1

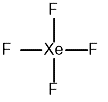
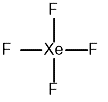
5. The point group to which XeF4 belongs: Oh D4h Td C4v

6. Using the labels as given, show the position of fluorine atoms following the σv’ and σv’’ symmetry operations as defined. Note: the unique, z axis is coming out of the plane towards you. Then, give the single operation (???) that will take the original to the final positions.

**Note: σv’ contains Xe, F1 and F3; σv” contains Xe, F2 and F4.**

?

σv’

σv’’

7. Now consider the Xe(=O)F4 molecule. Give its Lewis Structure and VSEPR predicted geometry. List one symmetry element that is the same as in XeF4 and at least 2 symmetry elements that are lost compared to XeF4? What is the point group of Xe(=O)F4 ?

2. Phosphorus exists as 31P in 100% natural abundance. The artificial (man-made) radio-isotope 32P has a half-life of 14.3 days and decays by ejection of a β- (an electron) from its nucleus. What is the resulting element? How long will it take for approximately 90% of the 32P radioisotope to decay?

32P ?? + β-

1. Give the electronic configuration of atomic P expressed as 1s2, 2s2, . . . What is the effective nuclear charge on the outermost electron of P? (Note: Slater’s rules are provided. Show your work.)

1. Give the ground state term symbol for P. Hint: First give the electronic configuration of the valence shell electrons in the box diagram approach and show the ml values on the boxes. Repeat this exercise for an excited state P\* where one of the 3s electrons has been promoted to a 3d orbital. For full credit, show your work/reasoning.
2. Ground state P:
3. Excited state P\*:
4. From this promoted or excited state, P, hybrid orbitals are constructed to account for the five valence bonds in PCl5. If energy is required to achieve these hybrids orbitals on P, why is the formation of PCl5 exothermic?
5. Give the Lewis structures and sketch out the VSEPR predicted molecular structures for the following molecules or molecular ions. For each, give the hybrid orbitals needed by the central atom. Also, give the Principal rotation axis and at least one of the key symmetry elements required to make the symmetry point group assignment.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Lewis**  **structure** | **VSEPR**  **Predicted structure**  **-------------**  **And hybridization** | **Principal**  **rot’n axis and**  **key symmetry**  **elements** | **Pt. Group** |
| 1. HCN |  |  |  |  |
| 1. PF3Cl2 |  |  |  |  |
| 1. SO32- |  |  |  |  |

For Grading Use:

|  |  |  |
| --- | --- | --- |
| **Question** | Points possible | **Points received** |
| I | 24 |  |
| II | 24 |  |
| III | 20 |  |
| IV | 20 |  |
| V | 17 |  |
| VI | 18 |  |
| **Total** | **123** |  |

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

