CHEM 251 (Fall-2003)
Exam 1 (100 pts)

Name: ----------, SSN ----------
LAST NAME, First
(Circle the alphabet segment of your LAST NAME): A-C D-H I-L M-S T-Z

Please answer the following questions:

Part I: Multiple Choices (52 pts: 13 @ 4 pts each). **Circle** the ***ONE*** best answer:

1. Which of the following atoms has the lowest first ionization energy (IE_1)?

   a) P b) Se c) S d) Cl

2. When an element # 119 is discovered, most likely it will be classified as a(n)

   a) halogen b) alkali metal
   c) transition metal d) noble gas

3. What is the electron configuration of Bi atom?

   a) $[Xe]\ {}_4f^{14}\ {}_5d^{10}\ {}_6s^2\ {}_6p^3$ b) $[Xe]\ {}_4f^{14}\ {}_6d^{10}\ {}_6s^2\ {}_6p^3$
   c) $[Xe]\ {}_4f^{14}\ {}_5d^{10}\ {}_6p^5$ d) $[Xe]\ {}_5d^{10}\ {}_6s^2\ {}_6p^3$

4. What is the predicted shape of XeF_4?

   a) Tetrahedral b) distorted tetrahedral
   c) octahedral d) square planar

5. Which of the following species is expected to be *polar*?

   a) XeF_4 b) BeF_2
   c) BF_3 d) SF_4

6. Which one of the following species has a Lewis structure similar to that of O_3?

   a) CO_2 b) N_3^-
   c) OCN^- d) SO_2

7. Which of the following species has the *shortest* S-O bond?

   a) SO_2 b) SO_3^{2-}
   c) SO_3 d) SO_4^{2-}

8. Which of the following species is expected to be *paramagnetic*?

   a) Be_2 b) Li_2
   c) B_2 d) F_2

9. Most noble gases do not readly combine with other elements. One exception to this is the combination of Xe with F. This can be explained by considering the relatively:
(**1**) ionization energy of Xe along with (**2**) electron affinity of F

	(**1**)	(**2**)
a)	low	high
b)	low	low
c)	high	high
d)	high	low

10. From the top to the bottom within a group of elements in the Periodic Table, the ionization energy generally:

a) decreases, because the nuclear charge increases

b) decreases, because the atomic size increases

c) increases, because the nuclear charge increases

d) increases, because the atomic size increases

11. Use the shapes of these third shell orbitals to arrange them in order of increasing energy (lowest to highest) for a ground state silicon atom:

a) **1** = **2** = **3** = **4** = **5**

b) **3** < **1** = **2** = **5** < **4**

c) **3** < **1** < **4** < **5** < **2**

d) **3** < **1** = **5** < **4** = **2**

12. For a single electron in the 4d orbital, which of the following set of quantum numbers is NOT considered as allowed values:

a) $n = 4, \ell = 2, m_\ell = -2, m_s = +\frac{1}{2}$

b) $n = 4, \ell = 2, m_\ell = 0, m_s = -\frac{1}{2}$

c) $n = 4, \ell = 2, m_\ell = 1, m_s = -\frac{1}{2}$

d) $n = 4, \ell = 3, m_\ell = +2, m_s = +\frac{1}{2}$

13. The first four ionization energies of an atom X are 403, 2633, 3900 and 5080 kJ/mol. To what periodic group X belongs?

a) Group **4** b) Group **2** c) Group **14** d) Group **16**

Part II (48 pts: 4 @ 12 pts) **Show all work for full credit. Please express all answers with proper units and correct number of significant figures**.

1. (a) Construct an MO diagram for the formation of O_2; show only the participation of the valence orbitals of the oxygen atoms. (b) Use the diagram to rationalize the following trend in O-O bond distances: O_2, 121 pm; O_2^+, 112 pm; O_2^-, 134 pm; O_2^{2-}, 149 pm. (c) Which of these species are paramagnetic?

2. Use te following data to estimate the bond dissociation enthalpy of HF: D(H-H) = 436 kJ/mol; D(F-F) = 158 kJ/mol; χ^P (H) = 2.2; χ^P (F) = 4.0

D(HF) =

3. The bond angles 117°, 134°, and 180° belong to the species NO_2^+, NO_2^-, and NO_2, but not in that order. Match the species with their bond angles and explain your answer.

4. a) Explain why the laughing gas N_2O exists in the arrangement NNO rather than NON?

   b) Carbon monoxide, CO has a small dipole moment (0.12 D). Explain why this molecule binds transition metals from the carbon end and not from the oxygen end?

PREFERENCE SHEET FOR CHEM 251

Exam 1 – Fall 2003

You will have 50 minutes to complete this exam.
The exam has 4 pages plus Periodic Table and Reference page.

When you are told to do so, tear off the Periodic Table cover sheet and use as required during exam.

Useful Information:

1.0 eV ≈ 96.5 kJ/mol

Useful Equations:

$\sqrt{\Delta D} = \chi^P (F) - \chi^P (H)$

Periodic Table of the Elements

1	1 **H** 1.01																2 **He** 4.00
2	3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
3	11 **Na** 22.99	12 **Mg** 24.30											13 **Al** 26.98	14 **Si** 28.08	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
4	19 **K** 39.1	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.88	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.38	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
5	37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.1
6	55 **Cs** 132.9	56 **Ba** 137.3	57 **La** 138.9	72 **Hf** 178.5	73 **Ta** 181.0	74 **W** 183.8	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
7	87 **Fr** (223)	88 **Ra** 226.0	89 **Ac** 227.0	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)	110 **Uun** (269)	111 **Uuu** (272)	112 **Uub** (277)						

58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.2	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** 237.0	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)