Name _____ Test 1 (10/4)
CHEM 0211 (Adv Inorganic) Fall 2010

1. (8 pts. ea.) Draw Lewis structures for the following molecules.

a. PCl_5 b. Cl_2SO_2

1. _____

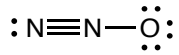
2. _____

3. _____

4. _____

2. a. (8 pts. ea.) Draw resonance structures for the following Lewis structure.

b. (6 pts. ea.) Rank the structures from lower (1) to higher (2, 3, etc) energy.



5. _____

6. _____

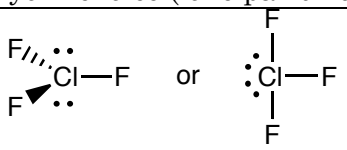
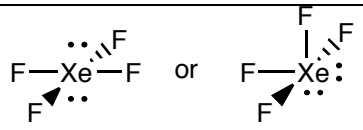
7. _____

8. _____

3. (8 pts. ea.) Determine the three-dimensional shapes of the following molecules and explain your choice (lone pairs not on the central atom have been omitted for clarity).

9. _____

10. _____

a.	b.
	

4. a. (6 pts.) An electron has the quantum numbers n = 5, l = 2, m_l = 0, $m_s = -1/2$. Is this an allowed state? If so, what is the orbital designation for this electron? If it is not, explain why it isn't.

b. (6 pts.) An electron has the quantum numbers n = 2, l = 3, m_l = -1, $m_s = +1/2$. Is this an allowed state? If so, what is the orbital designation for this electron? If it is not, explain why it isn't.

5. (10 pts.) Briefly describe how elements are formed from hydrogen and helium. You do not need to explain how all the elements are formed, highlights about how some of the elements are formed is sufficient; nevertheless, you'll want to make certain that some of the elements are lighter elements and some are heavier elements.

6. a. (10 pts.) Even though fluorine has more protons, neutrons and electrons than Li, it is smaller than Li. Explain this observation.

b. (10 pts.) In general, as one moves from left to right across a period, it becomes more difficult to remove and electron from an atom. However, it is easier to remove and electron from an oxygen atom than it is to remove an electron from a nitrogen atom. Explain this observation.

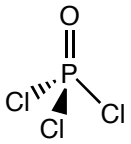
7. (10 pts.) Describe the traits that Mendeleev's table and the current periodic table have in common. Describe how they differ. (Please don't tell me that Mendeleev's table had fewer elements on it, unless of course, you are describing how the appearance of the table has changed, thanks.)

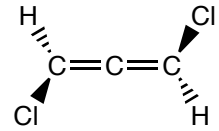
8. (8 pts.) For the C_{3v} point group determine the irreducible representation for the following reducible representation (Γ).

C_{3v}	E	2 C_3	3 σ_v
A_1	1	1	1
A_2	1	1	-1
E	2	-1	0
Γ	5	2	-1

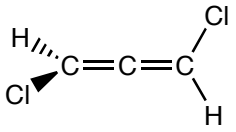
9. a. (4 pts. ea.) Determine the point groups of the following molecules.

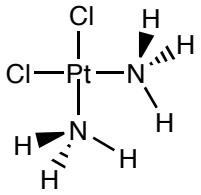
b. (2 pts. ea.) Label the chiral molecules (character tables are attached to the back of this exam).

i. 

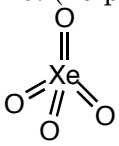
ii. 

two views of the same molecule

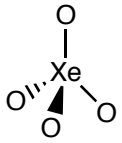


iii. 

10. (10 pts.) Predict the number of Xe=O stretching bands if XeO_4 has the following structure.



Kekulé



3D

a. Point group?

b. Reducible representation?

c. Irreducible representation?

d. Number of IR bands from Xe=O stretching?

Mendeleev's Table

Reihen	Gruppo I. — R^1O	Gruppo II. — RO	Gruppo III. — R^2O^3	Gruppo IV. RH^4 RO^2	Gruppo V. RH^3 R^2O^5	Gruppo VI. RH^2 RO^3	Gruppo VII. RH R^2O^7	Gruppo VIII. — RO^4
1	H=1							
2	Li=7	Be=9,4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27,3	Si=28	P=31	S=32	Cl=35,5	
4	K=39	Ca=40	—=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59, Ni=59, Cu=63.
5	(Cu=63)	Zn=65	—=68	—=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	—=100	Ru=104, Rh=104, Pd=106, Ag=108.
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	—	—	—	— — — —
9	(—)	—	—	—	—	—	—	
10	—	—	?Er=178	?La=180	Ta=182	W=184	—	Os=195, Ir=197, Pt=198, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Th=231	—	U=240	—	— — — —

http://en.wikipedia.org/wiki/File:Mendelejevs_periodiska_system_1871.png

Slater's Rules for Determining Effective Nuclear Charge

$$Z_{eff} = Z - S$$

Where Z_{eff} = effective nuclear charge, Z = nuclear charge, and S = shielding constant

1. list orbitals by n and *l*
   (1s) (2s,2p) (3s,3p) (3d) (4s, 4p) (4d) (4f) (5s, 5p) (5d) (etc)
2. electrons in groups to the right do not shield electrons to their left
3. S can be determined for *ns* and *np* electrons
   a. each electron in the same group contributes 0.35 to the value of S for other electrons in the same group
      exception, 1s electron contributes 0.30
   b. each electron in n - 1 groups contribute 0.85 to S
   c. each electron in n - 2 groups contribute 1.00 to S
4. for *nd* and *nf*
   a. each electron in the same group contributes 0.35 to the value of S (same as 3a)
   b. each electron in a group to the left contributes 1.00 to S

C_2	E	C_2		
A	1	1	R_x, R_y, R_z	x^2, y^2, z^2, xy
B	1	-1	x, y, z	xz, yz

C_{2h}	E	C_2	*i*	σ_h		
A_g	1	1	1	1	R_z	x^2, y^2, z^2, xy
B_g	1	-1	1	-1	R_x, R_y	xz, yz
A_u	1	1	-1	-1	z	
B_u	1	-1	-1	1	x, y	

C_{2v}	E	C_2	$\sigma_v(xz)$	$\sigma_v(yz)$		
A_1	1	1	1	1	z	x^2, y^2, z^2
A_2	1	1	-1	-1	R_z	xy
B_1	1	-1	1	-1	x, R_y	xz
B_2	1	-1	-1	1	y, R_x	yz

C_{3v}	E	2 C_3	3 σ_v		
A_1	1	1	1	z	$x^2 + y^2$, z^2
A_2	1	1	-1	R_z	
E	2	-1	0	(x, y), (R_x, R_y)	($x^2 - y^2$, xy), (xz, yz)

C_{4v}	E	2 C_4	C_2	2 σ_v	2 σ_d		
A_1	1	1	1	1	1	z	$x^2 + y^2$, z^2
A_2	1	1	1	-1	-1	R_z	
B_1	1	-1	1	1	-1		$x^2 - y^2$
B_2	1	-1	1	-1	1		xy
E	2	0	-2	0	0	(x, y), (R_x, R_y)	(xz, yz)

T_d	E	8 C_3	3 C_2	6 S_4	6 σ_d		
A_1	1	1	1	1	1		$x^2 + y^2 + z^2$
A_2	1	1	1	-1	-1		
E	2	-1	2	0	0		$2z^2 - x^2 - y^2$, $x^2 - y^2$
T_1	3	0	-1	1	-1	(R_x, R_y, R_z)	
T_2	3	0	-1	-1	1	(x, y, z)	(xy, xz, yz)

D_{2h}	E	$C_2(z)$	$C_2(y)$	$C_2(x)$	i	$\sigma_h(xy)$	$\sigma_d(xz)$	$\sigma_d(yz)$		
A_g	1	1	1	1	1	1	1	1		x^2, y^2, z^2
B_{1g}	1	1	-1	-1	1	1	-1	-1	R_z	xy
B_{2g}	1	-1	1	-1	1	-1	1	-1	R_y	xz
B_{3g}	1	-1	-1	1	1	-1	-1	1	R_x	yz
A_u	1	1	1	1	-1	-1	-1	-1		
B_{1u}	1	1	-1	-1	-1	-1	1	1	z	
B_{2u}	1	-1	1	-1	-1	1	-1	1	y	
B_{3u}	1	-1	-1	1	-1	1	1	-1	x	

S_4	E	C_2	$\sigma_v(xz)$	$\sigma_v(yz)$		
A	1	1	1	1	z	x^2, y^2, z^2
B	1	1	-1	-1	R_z	xy
E	1	i	-1	$-i$	(x, y) (R_x, R_y)	(xz, yz)
	1	-	-1	i		

number of irreducible representations of a given type needed = $^1/_{order}\,\Sigma_{classes}$[(# operations in class)(χ of the irreducible representation)(χ of the reducible representation)]