CHEM-1110 **TEST # 3** **NAME:**_____

July, 29,2003

1. For H-like species the energy of the electron is given by the formula

$$E_n = -\frac{1312(Z^2)}{n^2} kJ/mol$$

The ionization energy of H-like species X^{n+} in its ground state is 12.25 times larger than for the ground state of the He^+ ion. Determine X and n. **[4]**

$1312(Z^2) = 1312(2^2) \times 12.25$

$Z^2 = 49$

$Z = 7$

X is N

n is 6

The species is N^{6+}

2. The energy from radiation can be used to cause the rupture of chemical bonds. A minimum energy of 495 kJ/mol is required to break the oxygen to oxygen bond in O_2. What is the longest wavelength of radiation that possesses the necessary energy to break the bond and what type of electromagnetic radiation is this? **[4]**

$$E = 495 \frac{kJ}{mol} \times \frac{mol}{6.02\times10^{23}} \times \frac{10^3 J}{1 kJ} = 8.22\times10^{-19} J$$

$E = h\nu = hc/\lambda$

$$\lambda = \frac{hc}{E} = \frac{(6.63\times10^{-34} J\cdot s)(3.00\times10^{8} m/s)}{8.22\times10^{-19} J}$$

$= 2.42\times10^{-7} m = 242 nm$

3. An ion of He^+ can be treated like an H atom in terms of Bohr energy levels. If the electron of He^+ ion is excited to the n = 4 level, predict hov many different emission lines are possible as the electron relaxes to th ground state. **[2]**

n = 4 _____

n = 3 _____

n = 2 _____

n = 1 _____ 6

4. Give the **complete** ground state electron configuration, numbers of unpaired electrons, and indicate whether the species is paramagnetic c diamagnetic. **[4]**

Cr $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$ 6 PARA

Mo $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^5 5s^1$ 6 PARA

5. What is the theoretical maximum number of electrons that can be accommodated in the following energy levels? **[4]**

a) 7th shell. 98

b) 3d sub level. 10

c) 3f sub level. ϕ

d) 4s + 3d levels. 2+10 = 12

6. State whether or not each of the following is an acceptable designation for an atomic orbital. **[2]**

a) 1p NO

b) 4g NO

7. What is the total number of orbitals in the 6th shell? **[1]**
36

8. What is the total number of electrons in the 6th shell with $m_l = 0$ and $m_s = ½$? **[1]** 6

9. Which of the following are possible sets of quantum numbers for an electron in an atom (write OK)? For the sets of quantum numbers that are not possible, state what is wrong with each set. **[4]**

	n	l	m_l	m_s	
a)	1	o	1	+1/2	If n=1 then l must be 0 & m_l = 0
b)	6	5	5	-1/2	OK
c)	3	2	3	+1/2	If n=3 then l is 0, 1 or 2
d)	2	1	0	0	NO b/c m_s must be $\pm\frac{1}{2}$

10. Given below are several electron configurations for the oxygen atom. Indicate whether each represents the ground state, excited state, or an impossible state and also give the charge. **[4]**

a) $1s^2 2s^2 2p^3$ G.S. ZERO

b) $1s^2 2s^2 2p^3 3s^1$ E.S. ZERO

c) $1s^2 2s^2 2p^3 2d^1$ NOT POSSIBLE

d) $1s^2 2s^2 2p^2 5f^1$ E.S. ZERO

11. Consider the element Tantalum, Z=73. Give the number of **[4]**

a) 2p electrons that have $m_s = ½$ 3

b) 2s + 4d electrons that have $m_l = 0$ 4

c) all electrons that have $m_l = +1$ 15

d) all electrons with $m_l = 0$ and m_s=-1/2 27

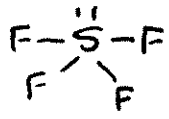
12. Give the formula of a cation and an anion that is isoelectronic with Xe.

[1] Cs^+ and I^-

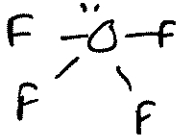
13. Select the best answer and write it on the line. **[11]**

a) largest radius	Na, Li, F	Na
b) largest 1st IE	P, Se, S	P
c) smallest radius	Se^{2-}, K^+, Ca^{2+}	Ca^{2+}
d) smallest lattice energy	MgO, NaCl, CsCl	CsCl
e) largest electronegativity	Sb, O, N	O
f) most unpaired electrons	I, As, Cr	Cr
g) most polar bond	CsCl, Cl_2, HCl	CsCl
j) largest dipole moment	SiH_4, NH_3, NF_3	NH_3
k) largest bond angle	NO_2, NO_2^{1-}, NO_2^+	NO_2^+
l) largest 2nd IE	K^+, Ca^+, Na^+	Na^+
m) least negative EA	Cr, Cl, Br	Cr

14. Explain why SF_4 can exist while OF_4 cannot exist. **[2]**

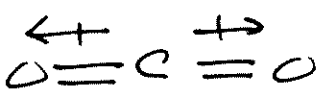


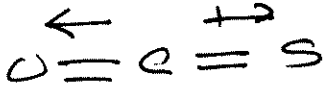
S can accommodate 5 pairs of $\bar{e}$ in its valence shell as S can use its d orbitals



O can't have more than 8 electrons in its valence shell as O does not have d-orbitals.

15. Explain CO_2 is non polar while OCS is polar. **[2]**



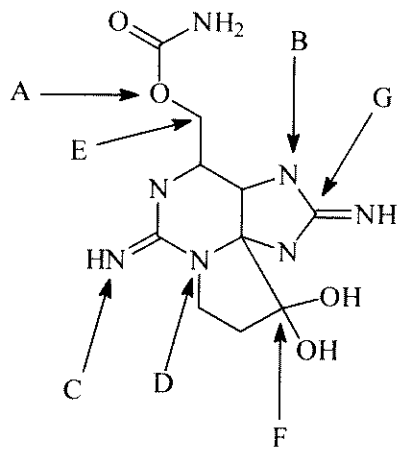


Both are linear. In OCS the two dipoles don't cancel out like they do in OCO.

16. Complete the following table: **[12]**

SPECIES	NAME OF MOLECULAR SHAPE	HYBRIDIZATION OF THE CENTRAL ATOM UNDERLINED	POLAR OR NONPOLAR
$\underline{Kr}F_2$ AB_2E_3	LINEAR	sp^3d	NP
$\underline{I}F_4^+$ AB_4E	SEESAW	sp^3d	P
$\underline{As}Cl_3$ AB_3E	TRIGONAL PYRAMIDAL	sp^3	P
$\underline{Xe}OF_2$ AB_2E_2	T-SHAPED	sp^3d	P
$\underline{I}Br_2^-$ AB_2E_3	LINEAR	sp^3d	NP
$O_2\underline{N}Cl$ AB_3	TRIANGULAR PLANAR	sp^2	P
$F_3\underline{Cl}O_2$ AB_5	TRIGONAL BIPYRAMIDAL	sp^3d	DEPENDS ON WHERE F ARE LOCATED.
$\underline{Br}F_5$ AB_5E	SQUARE BASED PYRAMID	sp^3d^2	P

17. Saxitoxin is a fatally toxic natural product produced by certain marin organism. The molecules occasionally accumulate in clams and musc during condition of red tide. **[6]**



Saxitoxir

Give the hybridization for the atoms labeled

A: sp^3 B: sp^3 C: sp^2 D: sp^3

Give approximate bond angles about the atoms labeled

E: $<109.5^\circ$ F: $<109.5^\circ$ G: $<120^\circ$

c) How many pi bonds are there? 3

d) How many lone pairs of electrons are there? 15

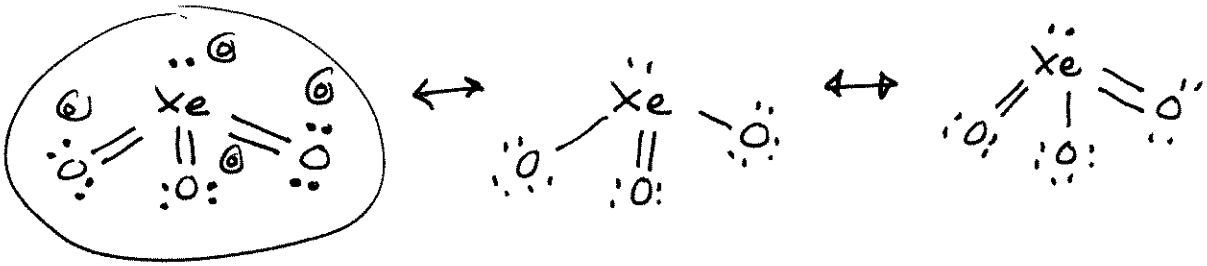
e) What is the total number of sp^2 hybrid orbitals? 18

f) What is the approximate size of the angle around

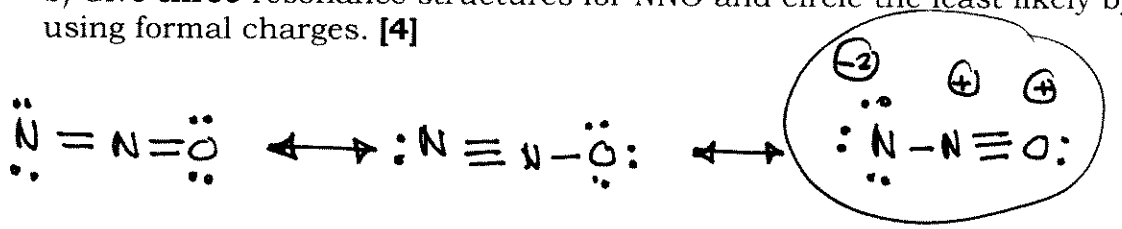
i) atom labeled G? $<120^\circ$

ii) atom labeled A? <109.5

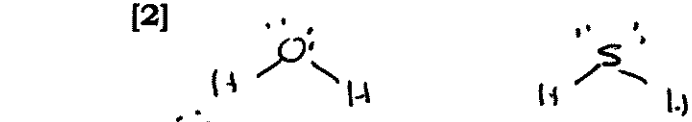
18. a) Give **three** resonance structures for $\underline{Xe}O_3$ and circle the most likely by using formal charges. **[4]**



b) Give **three** resonance structures for NNO and circle the least likely by using formal charges. **[4]**



19. Explain why H_2O is a liquid at room temperature while H_2S is a gas. **[2]**



Both molecules are polar. H_2S has stronger London force. But in H_2O there is H-bonding more in H_2S

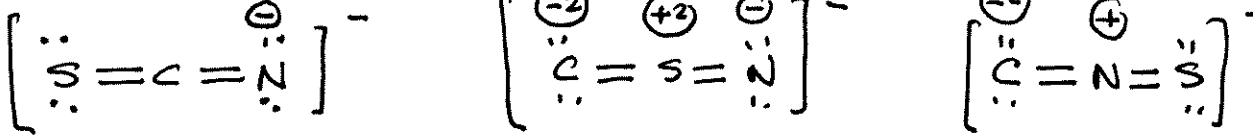
20. Arrange the following in increasing order of boiling point. **[2]**

C_2H_5OH, C_3H_8, $C_2H_5NH_2$, CH_3OCH_3

C_3H_8 CH_3OCH_3 $C_2H_5NH_2$ C_2H_5OH

LEAST HIGHEST

21. a) Write three different arrangements for SCN^- with three different central atom. Based on formal charges tell what is most likely to be the arrangement of atoms. **[4]**



Least formal charges.

b)Could these three different arrangements be called resonace forms of the same thing? EXPLAIN. **[1]**

NO.

In writing resonance forms, the connectivity order of atoms is never changed.