US 110 Exam 3. November 18, 2005

Name Key

You must show all work for credit. By submitting this assignment, I certify that I have neither given nor received unauthorized aid.

Useful Information: $\lambda\nu=c$, $c=3{,}00 \times 10^8$ m/s

(1)(4 pts) A radio station broadcasts a radio signal with a frequency of 1100 kHz. What is the wavelength of this radiation? Is it an FM or AM station?

$1100\ kHz \times \frac{1000\ Hz}{1\ kHz} = 1.100 \times 10^6\ Hz = 1.100 \times 10^{6}\ 1/s$

$\lambda(1.100 \times 10^{6}\ 1/s) = 3.00 \times 10^{8}\ m/s$

$\lambda = 273\ m$

(2)(2 pts) Put the following atoms in order from smallest to largest:

K, Ca, Rb, F, Cl

$F < Cl < Ca < K < Rb$

(3) (4 pts) Define the following:

(a) Hund's Rule Don't pair electrons unless it is necessary to do so to avoid violating the Aufbau Principle.

(b) The Aufbau Principle Electrons fill the lowest energy orbital possible.

(4)(4 points) Answer the following questions about quantum numbers.

(a) If l=4, how many electrons can the subshell hold?

$l=4 \therefore m_l = -4,-3,-2,-1,0,1,2,3,4$ 9 orbitals $\therefore$ $18e^-$

(b) How many electrons can the n=3 shell hold (all subshells combined)?

$n=3$ $l=0$ $m_l=0$
$l=1$ $m_l=-1,0,1$
$l=2$ $m_l=-2,-1,0,1,2$ 9 orbitals total, $\therefore$ $18e^-$

(5)(2 points) Draw a picture of the orbital with the following quantum numbers: n=4, l=2, m_l=-1.

$l=2$ d orbital

(6)(2 points) Place the following in the order of increasing electronegativity:
Cs, As, Ca, S, He

$Cs < Ca < As < S < He$

(7)(2 points) Place the following in the order of increasing size:
P, Cl, P^{3-}, Cl^-

$Cl < P < Cl^- < P^{3-}$

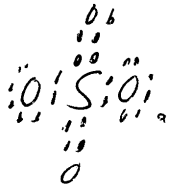
(8)(2 points) Which third row element should have the highest 3rd ionization energy?

Al Mg^{2+}

(9)(2 points) Place the following in the order of increasing electron affinity:
B, Ga, N, Ba, Cs

$Cs < Ba < Ga < B < N$

(10)(4 points) Draw the best Lewis dot structure(s) for SO_4^{2-}. Remember formal charge considerations.



S $C_f = 6-(6+0) = 0$

O_a $C_f = 6-(1+6) = -1$

$O_b = C_f = 6-(2+4) = 0$

(11)(8 points) Draw the Lewis dot structures for the following species. Draw the 3D stucture (VSPER) and give the name of the geometry. Then, list the hybridization of the central atom.

(a) PF_6^-

P $5e^-$

6F $42e^-$

1- $1e^-$

$48e^-$

octahedral

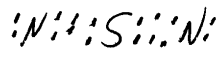
sp^3d^2

(b) SN_2

S $6e^-$

2N $10e^-$

$16e^-$

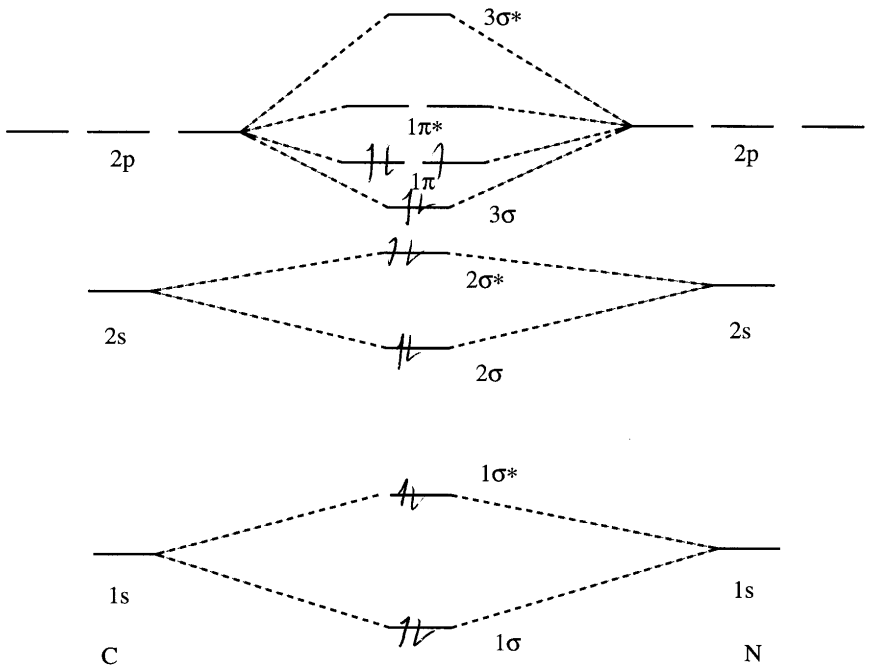


N–S–N

linear

sp

(12)(6 points)



(a) What is the ground state electron configuration of CN?

C+N = 13e⁻ $1\sigma^2 1\sigma^{*2} 2\sigma^2 2\sigma^{*2} 3\sigma^2 1\pi^3$

(b) What is the bond order of CN?

$BO = \frac{9-4}{2} = \frac{5}{2}$

(c) What should have a shortest ~~bond~~ distance, CN, CN^+ or CN^-?

CN^+ $\frac{8-4}{2} = \frac{4}{2} = 2$ BO CN^- BO $= \frac{10-4}{2} = 3$ ∴ CN^-

(13)(4 points) Using the MO diagram in problem 12, write the ground state molecular orbital configurations for the following diatomic molecules and ions

(a) NO^- 7+8+1 = 16e⁻ $1\sigma^2 1\sigma^{*2} 2\sigma^2 2\sigma^{*2} 3\sigma^2 1\pi^4 1\pi^{*2}$

(b) OF 8+7 = 17e⁻ $1\sigma^2 1\sigma^{*2} 2\sigma^2 2\sigma^{*2} 3\sigma^2 1\pi^4 1\pi^{*3}$

(14)(8 points) Create a Born-Haber cycle to find the ΔH for the reaction below using the following information.

$Mg(s) + F_2(g) \text{ -----> } MgF_2(s)$ ΔH= ??

F_2 bond dissociation energy = 155 kJ/mole
Mg $\Delta H_{sublimation}$ = 146 kJ/mole
Mg (g): E_{i1} = 782 kJ/mole, E_{i2} = 1451 kJ/mole
F(g) Electron Affinity = -328 kJ/mole
U for the reaction is 1950 kJ/mole