CHEM 14A
Instructor: Dr. Laurence Lavelle

YOUR NAME ANSWERS

ID# .....

FALL 2003
2nd MIDTERM

(Total number of pages = 8)

(Total points = 50)

(Total time = 50 mins)

Carefully remove last page which is your Periodic Table.

YOUR DISCUSSION SECTION or YOUR TA's NAME .....

WRITE IN PEN (Show all your work on this paper.)

Constants and Formulas

Planck constant, $h = 6.63 \times 10^{-34}$ J · s

Avogadro constant, $N_A = 6.02 \times 10^{23}$ mol^{-1}

Rydberg constant, $\mathbb{R} = 3.29 \times 10^{15}$ Hz

Gas constant, $R = 8.314$ $J.K^{-1}.mol^{-1}$

Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg

Speed of light, $c = 3.0 \times 10^{8}$ $m.s^{-1}$

$0°C = 273.15$ K $1L = 1\ dm^3$ 1 atm = 101.325 kPa $\pi = 3.14$

$E = h\nu$ $E = pc$ $E_n = \frac{h^2n^2}{8\,m\,L^2}$ $p = mv$

$E_n = -\frac{h\mathcal{R}}{n^2}$ $\lambda = \frac{h}{p}$ $c = \lambda\nu$

$pH = pK_A + LOG\frac{[A^-]_{INITIAL\ SALT}}{[AH]_{INITIAL\ ACID}}$ $E = \frac{1}{2}mv^2$ $\Delta p \times \Delta x \geq \frac{h}{4\pi}$

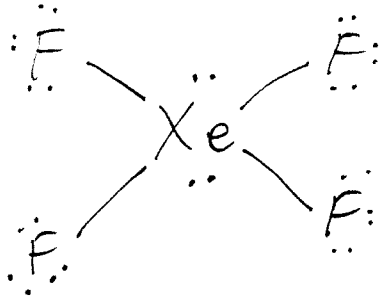
Solution to $AX^2 + BX + C = 0$ is $X = \frac{-B +/- \sqrt{B^2 - 4AC}}{2A}$

Q1A. What is the shape of XeF_4 ? (4pt)

Xe 8e⁻

4X F 4×7e⁻ = 28e⁻

36e⁻



(2 pt) partial

square planar (4pt)

Q1B. What is the shape of IF_4^+ ? (4pt)

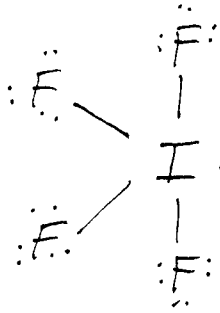
I 7e⁻

4X F 4×7e⁻ = 28e⁻

35e⁻

−1e⁻

34e⁻



(2 pt) partial

seesaw (4 pt)

Q2A. Which of the following is polar ? Circle your answer. (4pt)

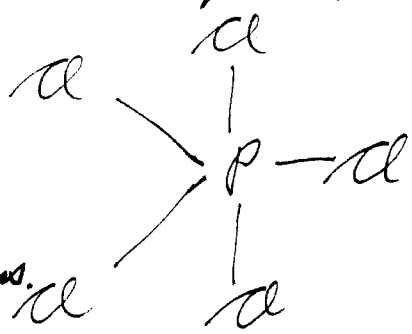
XeF_4 ← see Q1A. square planar

PCl_5

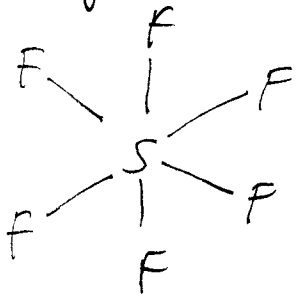
SF_6

IF_5

−2 pt if more than one ans.



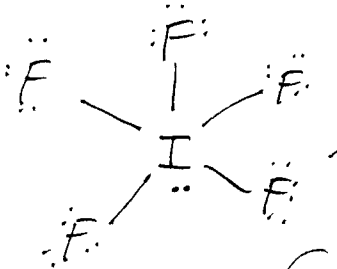
40 e^-



I 7 e^-

5 × F 5 × 7 e^- = 35 e^-

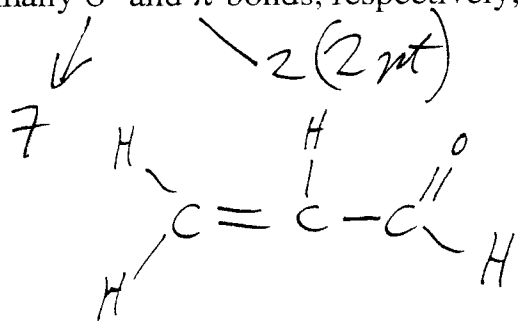
42 e^-



square pyramidal

IF_5 (4 pt)

Q2B. How many σ- and π-bonds, respectively, are there in acrolein, CH_2=CHCHO ? (4pt)



7 (2 pt) 2 (2 pt)

7 and 2

Q3A. The hybrid orbitals used by the underlined atoms in $CH_3\underline{C}H_2\underline{O}CH_2CH_3$, from left to right, respectively, are (4pt)

(2pt) sp^3 and sp^3 (2pt)

Q3B. The experimental observation that B_2 has two unpaired electrons indicates that, in molecular orbital ideas, (Circle your answer) (2pt)

the $2p_B$ orbitals lie above the $2p_\sigma$ orbital in energy.

the $2p_\pi$ orbitals lie below the $2p_\sigma$ orbital in energy.

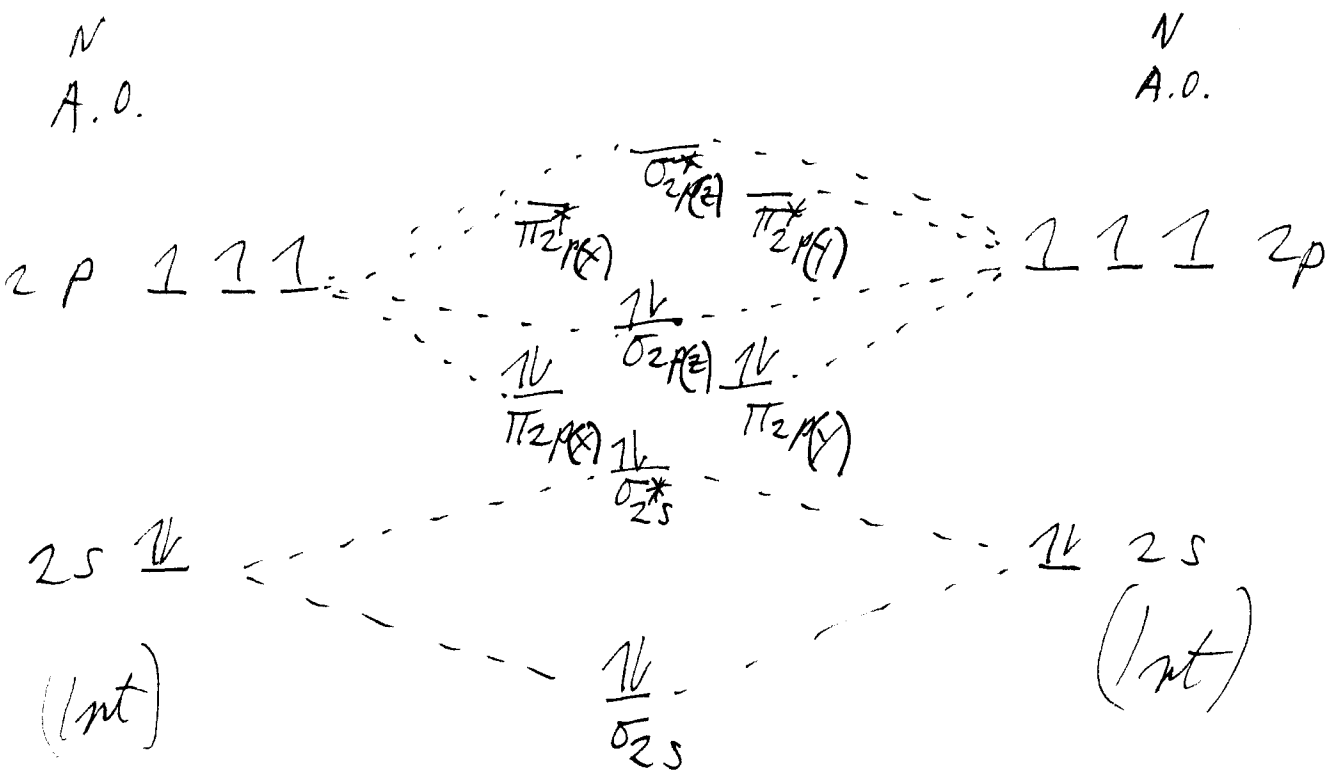
the $2p_\pi{}^*$ orbitals lie below the $2p_\sigma{}^*$ orbital in energy.

the $2p_\pi$ orbitals are nonbonding.

the $2p_\pi{}^*$ orbitals lie above the $2p_\sigma{}^*$ orbital in energy.

the $2p_\pi$ orbitals lie below the $2p_\sigma$ orbital in energy.

Q3C. Draw the molecular orbital energy-level diagram for N_2 and label the energy levels according to what type of orbitals they are made from, whether or not they are σ or π orbitals, and whether they are bonding or antibonding. (8pt)



2 pt for correct position of MOs electrons.
1 pt for correct σ label.
1 pt for correct π label.
1 pt for correct label of bonding MO.
1 pt for correct label of anti-bonding MO.

Q4A. The metalloproteins hemoglobin and vitamin B_{12} contain the metals _____ and _____, respectively. (2pt)

iron and cobalt, respectively.

Int Int

Q4B. Oxygen is stored in mammalian tissue in which type of molecule ? (2pt)

myoglobin

Q4C. Which transition metal is part of the electron-transfer molecules called cytochromes in the respiratory chain ? (2pt)

iron

Q4D. What is the oxidation number of cobalt in $[CoCl(NH_3)_5]Cl_2$? (2pt)

+3

Q4E. What is the formula for potassium hexacyanoferrate(II) ? (2pt)

$K_4[Fe(CN)_6]$

Int Int

Q5A. How many geometric isomers are possible for the complex $[Co(en)(OH_2)Cl_3]$? (2pt)

2 (2pt)

Q5B. How many different isomers of all types are possible for the complex ion $[Co(NCS)_2(NH_3)_4]^+$? (3pt)

6 (3pt)

Co – NCS
or
Co – SCN
or
CIS/TRANS

Q5C. Which of the following complexes is chiral ? (3pt)

trans-$[Co(ox)_2(OH_2)_2]^-$

trans-$[Co(ox)_2(OH_2)(NH_3)]^{3+}$

$[Co(ox)_3]^{3-}$

cis-$[Co(NH_3)_4(OH_2)_2]^{3+}$

$[Ru(OH_2)_3Cl_3]$

$[Co(ox)_3]^{3-}$

(3pt)

Q5D. Name one property that enantiomers have? (2pt)

They rotate plane-polarized light in opposite directions. (2pt)

or

Their structures are not superimposable. or (2pt)