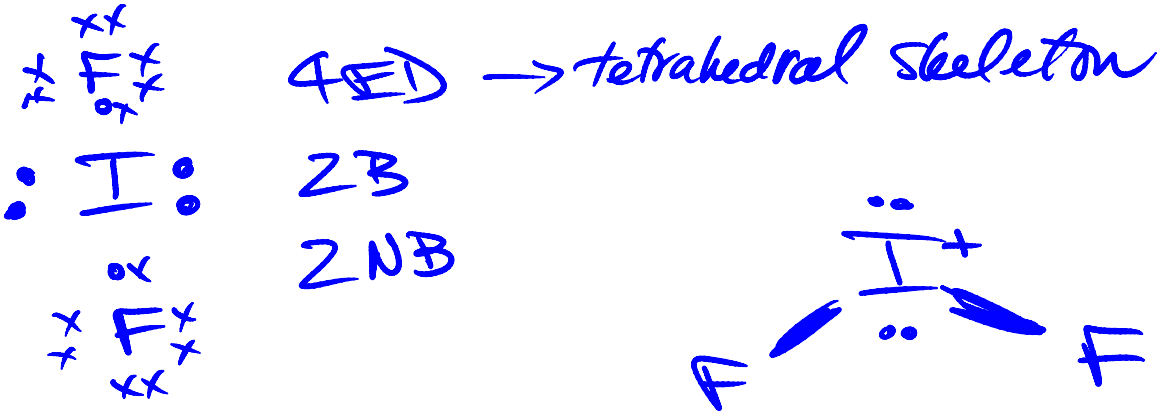
Self-Assessment Exam
Bonding and Molecules

Solution Key

2009 Test #1, Problem #3

Answer the following questions about the difluoroiodate ion (IF_2^+).

(a) Draw a 3-dimensional representation of the molecular geometry around the central atom (not simply the Lewis structure). Show all atoms and bonds between them.



(b) Name the type of hybrid orbitals that the central atom forms. sp^3

(c) Name the molecular geometry of the compound. bent or V-shaped

(d) Is IF_2^+ polar or nonpolar? Explain.

polar. asymmetric dist^n of polar I–F bonds
I is $\delta+$; Fs are $\delta-$

(e) Determine the maximum wavelength of electromagnetic radiation capable of breaking the I–F bond.
Bond energies(kJ/mol): F–F = 160 I–I = 150

use Pauling formula to get E of the I–F bond

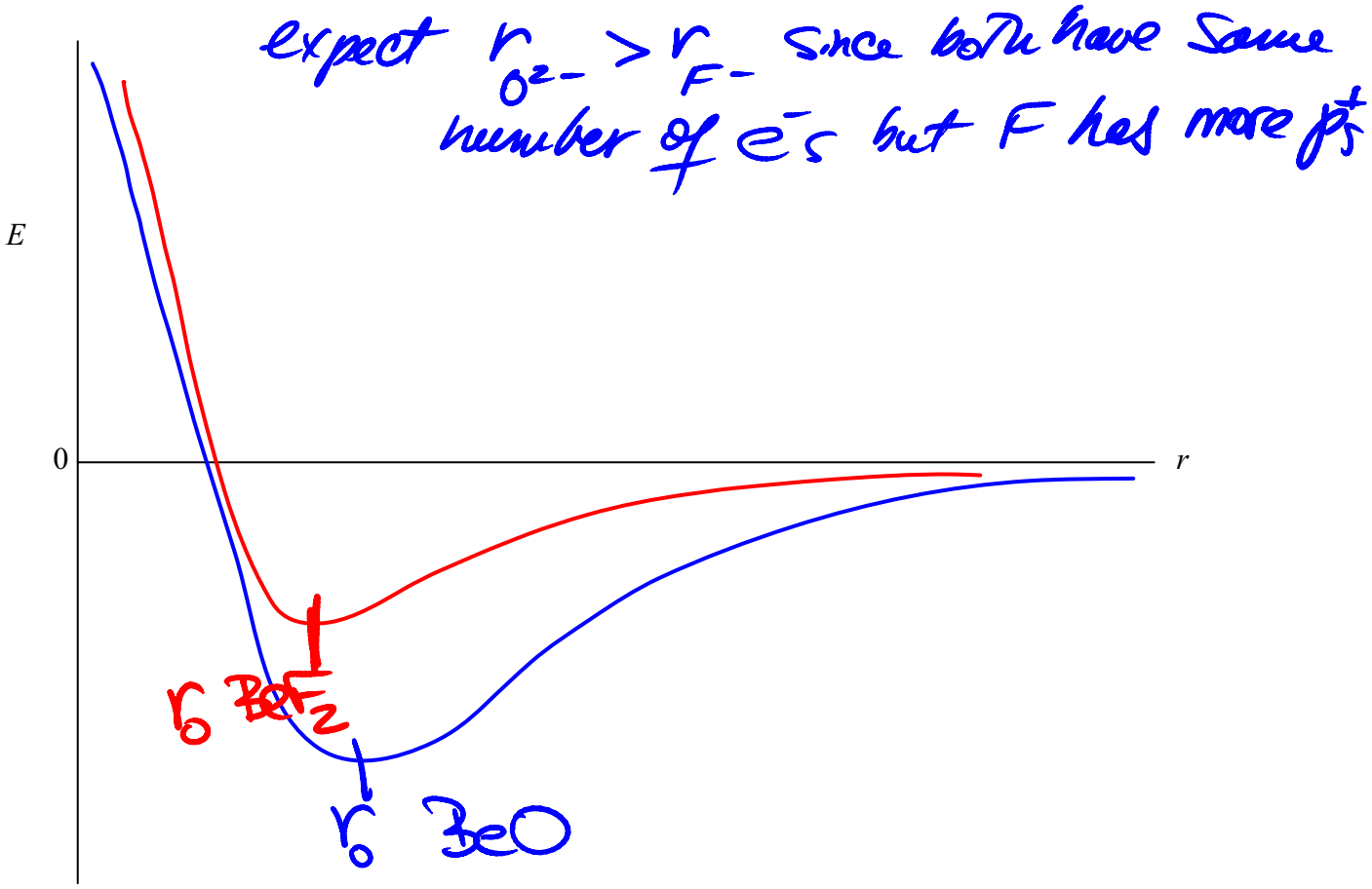
$$E_{IF} = \left(E_{I-I} \cdot E_{F-F}\right)^{1/2} + 96.3\left(\chi_I - \chi_F\right)^2 = 155 + 168 = 323\ \frac{kJ}{mol}$$

$$E_{radiation} = E_{IF\ bond} = \frac{hc}{\lambda}$$

$$\therefore \lambda = \frac{6.6\times10^{-34}\times3\times10^{8}}{\frac{323\times10^{3}}{6.02\times10^{23}}} = 3.69\times10^{-7}\ m$$

2009 Test #1, Problem #5

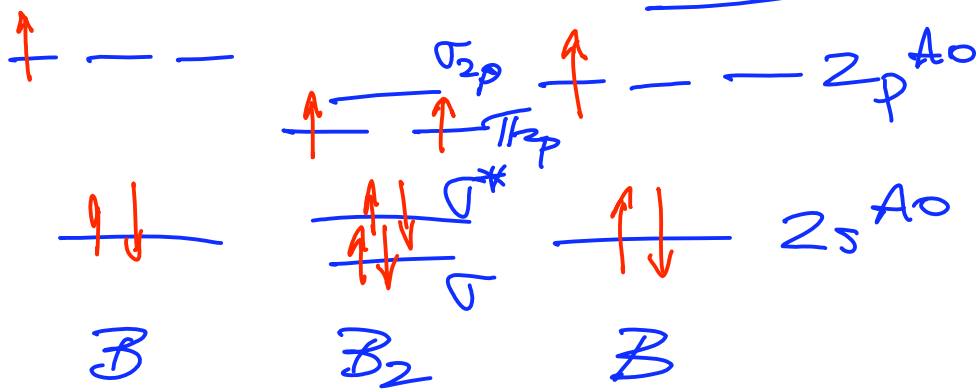
On the same graph below, for (1) BeF_2; and (2) BeO, sketch the variation in potential energy, $E_{potential}$ with internuclear separation, r, between a cation and anion pair in each compound. The diagram need not be drawn to scale; however, you must convey the relative magnitudes of key features.



2009 Test #2, Problem #4

(a) Boron exists in the gas state as the dimer, B_2. Explain how the fact that B_2 is paramagnetic (two unpaired electrons) implies that in this molecule the π_{2p} orbitals must lie at a lower energy than do the σ_{2p}.

B is $2s^2 2p^1$ // only if $\pi_{2p} < \sigma_{2p}$ will the two 2p electrons be unpaired $\Rightarrow$ from diagram you can see that if $\sigma_{2p} < \pi_{2p}$ both electrons would occupy $\sigma_{2p} \Rightarrow$ paired



(b) Is the gas molecule, B_2^{2-}, more or less stable than the gas molecule, B_2? Explain.

- B_2^{2-} has two more electrons than B_2
- these two electrons pair up with the two unpaired electrons in the π_{2p} orbitals, thereby forming two bonds
- hence, we expect B_2^{2-} to be ***more stable*** than B_2

(c) Aluminum arsenide (AlAs) is a compound semiconductor with a band gap energy, E_g, of 2.3 eV. The value of E_g can be decreased by mixing AlAs with a compound semiconductor that has a smaller band gap energy. Name one such compound semiconductor and justify your choice by making reference to the operative chemical bonding.

smaller $E_g \Rightarrow$ weaker bond
$\Rightarrow$ greater internuclear sep^n

$\therefore$ choose group 13 below Al: Ga, In
group 15 below As: Sb

$\Rightarrow$ GaAs, InAs, AlSb

2009 Test #2, Problem #5

(a) Which compound do you expect to have the ***higher*** boiling point: HF or NH_3? Justify your choice with an explanation, using narrative or cartoons or both, that makes reference to the operative chemical bonding.

Compare ΔX within HF & NH_3
$\Rightarrow$ HF bond is more polar
also F has 3 nonbonding electron pairs
$\therefore$ HF capable of stronger H-bonding
$\Rightarrow$ expect HF to have higher b.p.

(b) To which does an atom of Ar form a stronger bond: another Ar atom or an atom of Kr? Justify your choice with an explanation, using narrative or cartoons or both, that makes reference to the operative chemical bonding.

- operative bonding in both cases is van der Waals
- Compare (Ar)(Ar) to (Ar)(Kr)

Kr has more electrons & is larger than Ar
$\therefore$ α(polarizability) of Kr $>$ α(Ar)
$\therefore$ Ar–Kr bond is stronger

3.091SC Introduction to Solid State Chemistry

Fall 2009