### 3.091 OCW Scholar

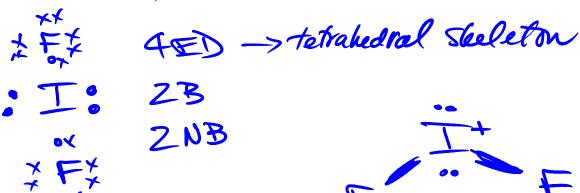
# Self-Assessment Exam Bonding and Molecules

# **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.
- (c) Name the molecular geometry of the compound.
- Is IF<sub>2</sub><sup>+</sup> polar or nonpolar? Explain.

  polar. Asymmetric dist of polar T-F bonds (d) Is IF<sub>2</sub><sup>+</sup> polar or nonpolar? Explain. I 15 St; Frame 5
- (e) Determine the maximum wavelength of electromagnetic radiation capable of breaking the I–F bond. Bond energies(kJ/mol): F - F = 160

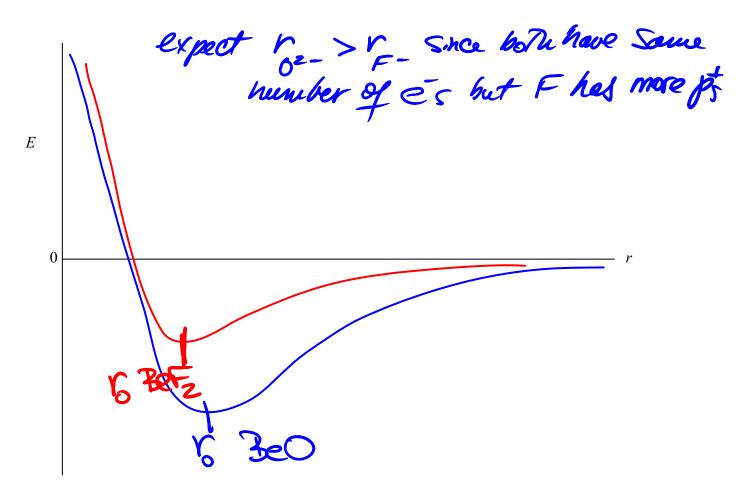
use Realing formula to get 
$$E \neq Re I-F band$$

$$E = \left(E_{I-I}E_{F-F}\right)^{1/2} + 96.3 \left(X_{I}-X_{F}\right) = 155 + 168 = 323 kT$$
The sum of the sum of

Endiation = 
$$E_{IF6md} = \frac{hc}{\lambda}$$
 $\frac{6.6 \times 10^{34} \times 3 \times 10^{8}}{323 \times 10^{3}} = 3.69 \times 10^{7} \text{ m}$ 
 $\frac{323 \times 10^{3}}{6.02 \times 10^{23}}$ 

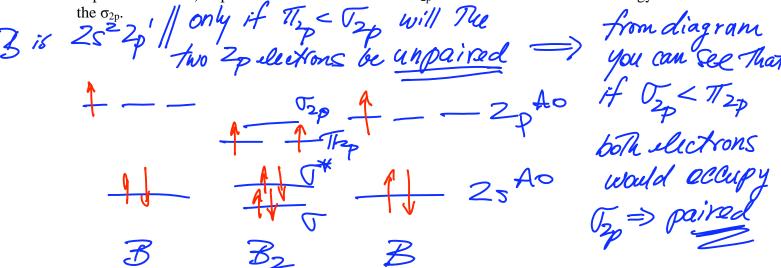
### 2009 Test #1, Problem #5

On the same graph below, for (1) BeF<sub>2</sub>; and (2) BeO, sketch the variation in potential energy,  $E_{\text{potential}}$  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  $\pi_{2p}$  orbitals must lie at a lower energy than do



(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  $\pi_{\rm 2p}$  orbitals, thereby forming two bonds
- hence, we expect B<sub>2</sub><sup>2-</sup> to be **more stable** than B<sub>2</sub>

(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.

Amaller Eg => weaker bond => greater internuclear sept : choose group 13 below Al: Ga, In group 15 below As: Sb => BaAs, In As, AlSb

### 2009 Test #2, Problem #5

(a) Which compound do you expect to have the *higher* boiling point: HF or NH<sub>3</sub>? Justify your choice with an explanation, using narrative or cartoons or both, that makes reference to the operative chemical bonding.

Compare  $\Delta X$  within HF & NHz  $\Rightarrow$  HF bond is more polar

also F has 3 nonbonding electron pairs

the capable of stronger H-bonding  $\Rightarrow$  Uppert 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 + An Kr

Kr has more electrons of is larger than Ar

30 × (polarizability) of Kr > X (Ar)

in Ar-Kr bond K Stronger

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