

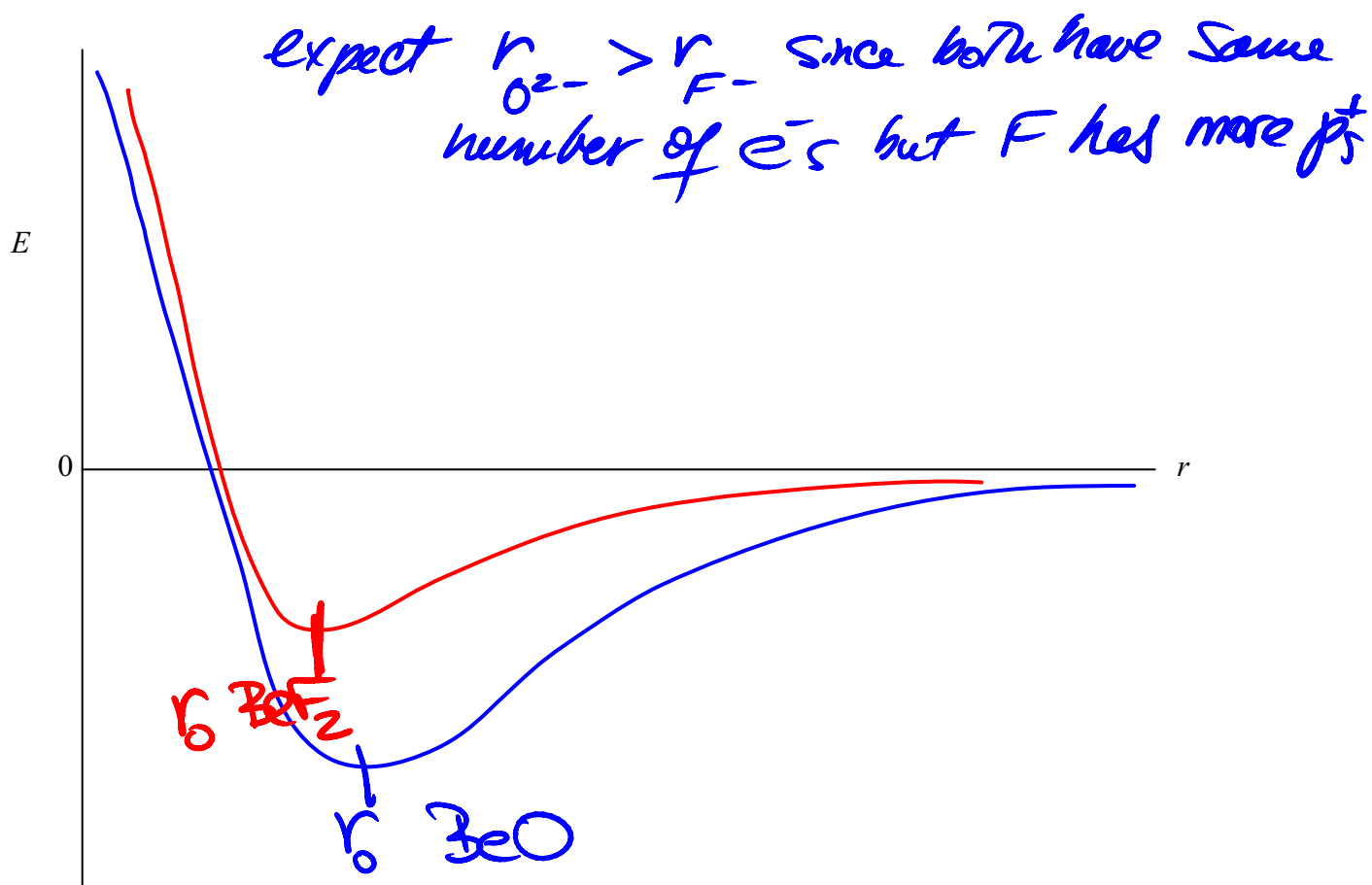
3.091 OCW Scholar

Self-Assessment Exam Bonding and Molecules

Solution Key

2009 Test #1, Problem #5

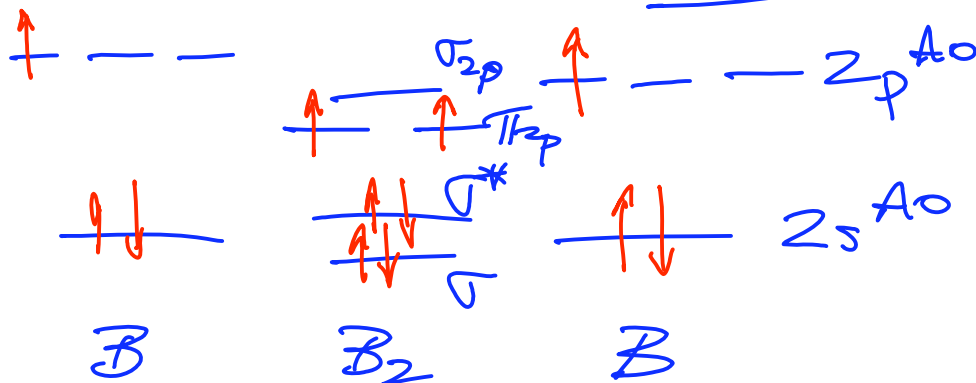
On the same graph below, for (1) BeF_2 ; and (2) BeO , sketch the variation in potential energy, $E_{\text{potential}}$ with internuclear separation, r , between a cation and anion pair in each compound. The diagram need not be drawn to scale; however, you must convey the relative magnitudes of key features.



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 π_{2p} orbitals must lie at a lower energy than do

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 sepⁿ

\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 NH₃? Justify your choice with an explanation, using narrative or cartoons or both, that makes reference to the operative chemical bonding.

Compare $\Delta\chi$ within HF & NH₃
⇒ HF bond is more polar
also F has 3 nonbonding electron pairs
∴ HF capable of stronger H-bonding
⇒ 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

∴ α (polarizability) of Kr > α (Ar)

∴ Ar-Kr bond is stronger

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