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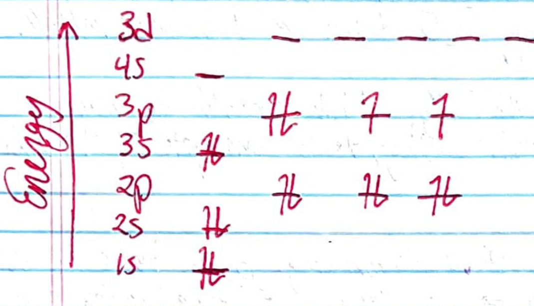
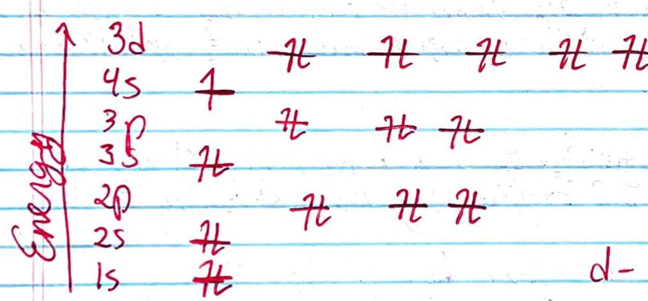
Week 8 Discussion Worksheet Answers

1) Correctly draw and fill in the orbital diagrams for the following atoms or ions

a) S atom

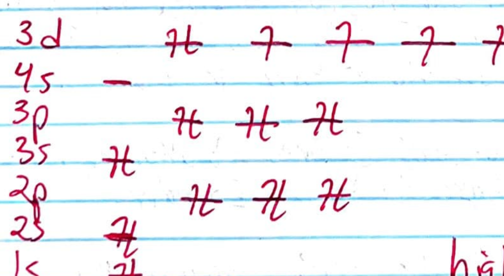


b) Cu atom



d-block exception?

c) Fe^{2+} ion



highest n e^- removed 1st?

2) Write the noble gas ground state electron configuration for each of the following atoms or ions:

a) B [He] $2s^2 2p^1$

b) Br^- [Ar] $4s^2 3d^{10} 4p^6$

c) Ba^{2+} [Kr] $5s^2 4d^{10} 5p^6$

d) Bi [Xe] $6s^2 5d^{10} 4f^{14} 6p^3$

e) Bk [Rn] $7s^2 6d^1 5f^8$

f) Bh [Rn] $7s^2 6d^5 5f^{14}$

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In the electron configuration above, circle the valence e^-

3) In the chemical reaction of first and second group metals with water, H_2O takes e^- from the metals to form H_2, cations, and OH^-. The more reactive the metal, the more readily it loses e^-; therefore, the more easily H_2O takes e^- from the metal.

a) Compare the reactivities of Na & Mg. Which should be more reactive with water? Explain Why, using concepts of shielding, Zeff, and atomic size.

Na should be more reactive than Mg. Both have 3s valence e^-. Mg has an extra proton ⇒ its valence e^- experiences greater Zeff than Na 3s. Hence Mg has smaller atomic radius and a more compact atom is less likely to give up an e^- to water. Na is the opposite and hence will more easily give up an e^-.

b) Compare the reactivities of Li and K. Which should be more reactive with water? Explain why using shielding & atomic size.

K is more reactive than Li. Li has valence in 2s, K has it in the 4s. 4s e^- are further from nucleus ⇒ K has larger atomic radius than Li. Further, K e^- experience better shielding from the nuclear charge by 3 inner n-levels e^- whereas Li valence e^- only has the 1s. So in general it is easier to remove the e^- from K than Li.

c) If we dropped a piece of Cs into a beaker of water, how reactive would you expect it to be? Explain.

Incredibly reactive! The further down the column, larger atomic radius, better shielding, and hence Zeff is decreased for valence electrons. Hence it is very easy to remove the valence e^- and this is why Cs has one of the lowest 1st IE on the periodic table.

4) In each of the following pairs, explain which should have the largest radius.

a) $\boxed{Sn}$ vs Sb

Both have valence in 5p orbital. Sb has one extra proton pulling e^- inward $\Rightarrow$ Sb has a more contracted atomic radius.

b) S vs $\boxed{S^{2-}}$

Anions are always larger than their neutral atoms because the extra e^- are repelled further from the nucleus, thus increasing overall atomic size.

c) $\boxed{Sr}$ vs Sr^{2+}

Cations are always smaller than neutral atoms because losing e^- causes Z_{eff} to be stronger. Pulls remaining e^- closer.

5) When non-metals react, they do so by gaining e^-, and the ease with which an atom gains an e^- is called electron affinity (EA). The most reactive non-metal is F.

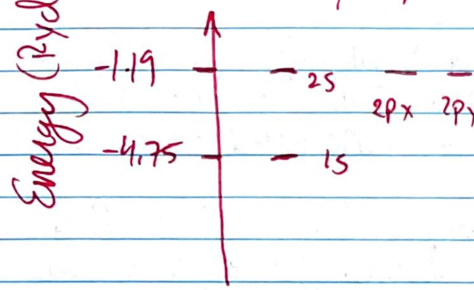
a) By comparing F to both C & Br, explain why F is the most reactive non-metal, using the concepts of shielding, Z_{eff}, and atomic size.

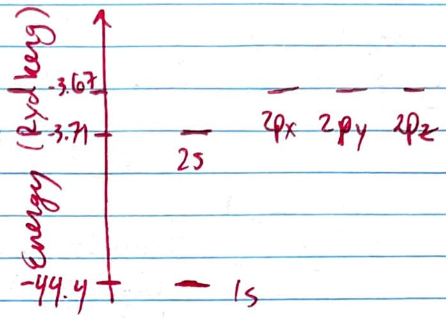
F vs C: F's 2s valence e^- experience greater Z_{eff} compared to carbons. F's pull on its e^- is so strong that it can pull in extra e^- much more easily than C can. So, non-metal reactivity involves gaining e^- $\Rightarrow$ F is much more suited to this than C.

F vs Br: Br's valence e^- in further shell $\Rightarrow$ experience less Z_{eff} compared to F's valence e^-. F's stronger pull $\Rightarrow$ can more easily pull in extra e^- vs. Bromine.

6) Draw the energy level diagram for a N atom including approximate energies of each energy level. What are the differences between H & N energy level diagrams? Only include n=1 and n=2.

Hydrogen

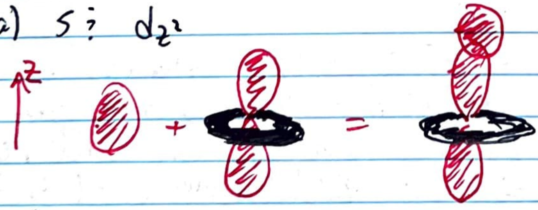




The difference comes from energy level spacing and the actual values of the energy. 1st Hydrogen does not have different energys for subshells because there is only 1e in the atom, thus no shielding. Additionally energies are calculated differently for each diagram. The energies for H diagram are exact, whereas the Nitrogen energies need to be calculated via the Hatree approximation.

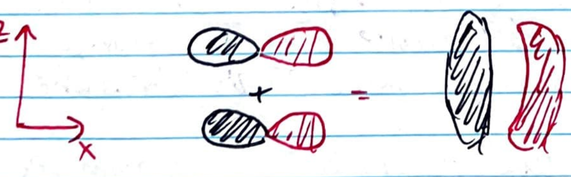
7) Draw the bonding overlap, if any, between the following sets of orbitals. Indicate if this overlap would result in a σ or π-bond.

a) s ; d_{z^2}



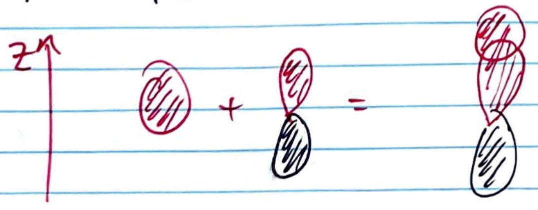
σ-bond

b) p_x ; p_x



π-bond

c) s ; p_z



σ-bond.