What is Valence Bond Theory?

Worksheet

Valence bond theory states that covalent bonds form from the overlap of atomic orbitals, with electron density concentrated between nuclei. Stronger overlap = stronger bond; orbital geometry determines bond angles.

Questions

1. Valence bond theory explains bonding through

A) delocalized molecular orbitals
B) atomic orbital overlap
C) electron transfer
D) colour of light

2. In a sigma () bond, electron density is

A) above and below the internuclear axis
B) directly between the nuclei
C) only on one atom
D) everywhere equally

3. Stronger orbital overlap results in

A) weaker bonds
B) stronger bonds
C) no bonds
D) ionic bonding

4. Pi () bonds result from

A) head-on overlap of s orbitals
B) head-on overlap of p orbitals
C) side-by-side overlap of p orbitals
D) s and p mixing

5. Explain how a covalent bond forms between two hydrogen atoms using VB theory.

6. What is the difference between sigma () and pi () bonds?

7. Why does the O-H bond have a specific angle in water (104.5)?

8. Define: Core idea of valence bond theory?

9. Define: Sigma vs. pi bond?

10. Define: How does orbital overlap relate to bond strength?

Answer Key

1. B) atomic orbital overlap - VB theory focuses on the overlap of atomic orbitals from two atoms forming a bond.

2. B) directly between the nuclei - bonds have maximum electron density along the line between nuclei (head-on overlap).

3. B) stronger bonds - More overlap = greater electron density between nuclei = stronger attractive force.

4. C) side-by-side overlap of p orbitals - bonds form from parallel p orbitals overlapping side-by-side, not head-on.

5. Each H atom has a half-filled 1s orbital with one electron As two H atoms approach, their 1s orbitals overlap Overlap creates electron density between nuclei Both electrons share the overlapping region; bond forms (H-H)

6. Sigma () bonds: head-on overlap of orbitals along the internuclear axis Electron density concentrated directly between nuclei Pi () bonds: side-by-side overlap of p orbitals Electron density above and below the internuclear axis

7. In HO, oxygen uses hybrid orbitals (sp) Hybrid orbitals point toward tetrahedral positions Two O-H bonds form along two of these positions The angle between them is 104.5 (slightly less than 109.5 due to lone pair repulsion)

8. Covalent bonds form when atomic orbitals overlap; stronger overlap means stronger bonding.

9. Sigma () = head-on overlap, electron density between nuclei. Pi () = side-by-side overlap, electron density above/below nuclei.

10. Greater orbital overlap creates stronger bonds because electrons concentrate more densely between nuclei.