Name: _____ **Date:** _____

Bonding Bliss: Orbital Overlaps and Molecular Mixology for College Chemists

Molecular Orbital Theory, hybridization, and lattice energy calculations — essential advanced mechanics for mastering structural inorganic chemistry and thermodynamics.

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1. In the context of Molecular Orbital (MO) theory for heteronuclear diatomic molecules like CO, which statement accurately describes the frontier orbitals?

A. The HOMO is primarily localized on the Carbon atom due to its lower electronegativity.
B. The LUMO is a non-bonding orbital centered entirely on the Oxygen atom.
C. The bonding MOs receive a greater contribution from the Carbon 2p orbitals.
D. The 1σ orbital is higher in energy than the 2σ orbital.

2. True or False: According to the Bent's Rule, central atoms with high electronegativity substituents will prefer to direct more p-character toward those substituents to decrease the bond energy.

A. True
B. False

3. To calculate the Lattice Energy of an ionic solid without experimental data, the _____ equation accounts for the Madelung constant and the Born exponent.

A. Henderson-Hasselbalch
B. Born-Landé
C. Nernst
D. Arrhenius

4. Which transition in the Walsh diagram for an AH2 molecule explains why H2O is bent while BeH2 is linear?

A. The stabilization of the 1b2 orbital as the bond angle decreases.
B. The destabilization of the 2a1 orbital as the bond angle increases.
C. The dramatic energy decrease of the 2a1 orbital upon bending from 180°.
D. The transition of the HOMO from a pi-bonding to a sigma-bonding state.

5. The phenomenon where a metal-ligand bond is strengthened by the synergistic transfer of electrons from a filled metal d-orbital to the ligand's empty π* orbital is called _____.

A. Chelation effect
B. π-backbonding
C. Sigma-induction
D. Ligand field stabilization

6. True or False: In a metallic crystal, the 'Fermi Level' refers to the energy level of the highest occupied electron state at absolute zero temperature.

A. True

Name: _____ **Date:** _____

B. False

7. Using Fajan's Rules, which of the following compounds would you predict to have the highest degree of covalent character?

A. LiCl
B. NaCl
C. BeI2
D. MgF2

8. In Valence Bond Theory, the mathematical process of combining atomic wavefunctions to produce new, equivalent spatial orientations is known as _____.

A. Linear Regression
B. Hybridization
C. Normalization
D. Quantization

9. True or False: A 'Formal Charge' of zero on all atoms in a Lewis structure always guarantees that the structure is the most accurate representation of the molecule's actual electronic distribution.

A. True
B. False

10. Which of the following conditions is required for the formation of a 'dative' (coordinate covalent) bond?

A. Both atoms must have half-filled orbitals of equal energy.
B. One atom must possess a lone pair while the other possesses an empty valence orbital.
C. The electronegativity difference between the two atoms must be greater than 2.0.
D. The atoms must be from the same period in the periodic table.