

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Vibrating Valence: Advanced Bonding Theory for 12th Grade Pros

Calculate formal charges and predict molecular geometries as if designing new semiconductor materials for the next generation of tech hardware.

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**1. Which transition metal complex exhibits Jahn-Teller distortion as a direct consequence of electronic degeneracy in its octahedrally coordinated d-orbitals?**

- A.  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$
- B.  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$
- C.  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$
- D.  $[\text{Fe}(\text{CN})_6]^{4-}$

**2. In Molecular Orbital (MO) theory, the bond order of the dioxygen cation ( $\text{O}_2^+$ ) is \_\_\_\_\_, which explains its increased stability compared to neutral  $\text{O}_2$ .**

- A. 1.5
- B. 2.0
- C. 2.5
- D. 3.0

**3. Based on VSEPR theory and hybridization in hypervalent molecules, Xenon tetrafluoride ( $\text{XeF}_4$ ) adopts a tetrahedral molecular geometry.**

- A. True
- B. False

**4. Using Fajan's Rules, which of the following compounds displays the highest degree of covalent character despite being classified as an ionic halide?**

- A.  $\text{LiF}$
- B.  $\text{NaCl}$
- C.  $\text{LiI}$
- D.  $\text{CsI}$

**5. In the context of Band Theory, a material where the valence band and conduction band overlap slightly, as seen in semi-metals like Bismuth, is known as a \_\_\_\_\_.**

- A. P-type dopant
- B. Semimetal
- C. Insulator
- D. Superconductor

**6. The boiling point of Phosphine ( $\text{PH}_3$ ) is higher than that of Ammonia ( $\text{NH}_3$ ) because Phosphorus is heavier than Nitrogen.**

- A. True

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B. False

**7. The molecule Boron Trifluoride (BF<sub>3</sub>) is a powerful Lewis Acid. What is the hybridization of the Boron atom and the resulting bond angle?**

- A. sp, 180°
- B. sp<sup>2</sup>, 120°
- C. sp<sup>3</sup>, 109.5°
- D. sp<sup>3</sup>d, 90°/120°

**8. According to the LCAO-MO method, the mixing of 2s and 2p atomic orbitals occurs in homonuclear diatomic molecules of elements with atomic numbers Z d\_\_\_\_, affecting the order of sigma and pi levels.**

- A. 5
- B. 7
- C. 8
- D. 10

**9. Which of the following compounds contains a coordinate covalent bond (dative bond)?**

- A. CH<sub>4</sub>
- B. NH<sub>4</sub><sup>+</sup>
- C. BeCl<sub>2</sub>
- D. KCl

**10. In a metallic lattice, the 'Sea of Electrons' model explains the ductility of metals because the non-directional nature of the bonds allows layers of atoms to slide over each other without breaking.**

- A. True
- B. False