1) Which of the following is true?

1. Lattice Energy depends on ionic size and ionic charge only.
2. Lattice Energy is the smallest component of the Born-Haber Cycle
3. Lattice Energy is the energy associated with an ionic solid separating into gaseous ions
4. Ionic Compounds conduct electricity very well as solids
5. Ionic solids only exist because the lattice energy is significantly larger than the total energy needed to form the ions

2) Which of the following fluorine-containing molecules or ions exhibits a tetrahedral molecular geometry?

(1) ClF₄⁺ (2) XeF₄ (3) SF₄ (4) BF₄⁻ (5) IF₄⁻

3) Find the Bond Order of H₂, N₂, and O₂ respectively

1. 0, 1, 2  2. 1, 3, 2  3. 2, 3, 1  4. 2, 1, 0  5. None of the Above

4) Which of the following is true?

1. Bond Order is the number of electron rich regions being shared by a given pair of atoms
2. The Bond Energy is the energy needed to create a covalent bond
3. Bond Order and Bond Energy are inversely related
4. Single bonds don’t always have a Bond Order of 1
5. The same quantity of energy absorbed to break a bond is the same amount of energy that is released when the bond forms.
5) Which of the following molecules show resonance? NO₂, CO₃²⁻, O₃
   (1) NO₂ only
   (2) CO₃²⁻ only
   (3) CO₃²⁻ and O₃
   (4) O₃ only
   (5) All three have resonance

6) Consider the following components of the Born-Haber cycle for the formation of NaBr from solid Na and gaseous Br₂, and use these components to calculate the lattice energy (ΔH_lattice) of solid NaBr.
   ΔH_{sublimation} of Na = +107 kJ/mol
   ΔH_{first-ionization} of Na = +496 kJ/mol
   ½ ΔH_{bond-energy} of Br₂ = +97 kJ/mol
   ΔH_{first-electron-affinity} of Br = −325 kJ/mol
   ΔH_{formation} of NaBr = −367 kJ/mol

   (1) −367 kJ/mol
   (2) −673 kJ/mol
   (3) −399 kJ/mol
   (4) −957 kJ/mol
   (5) −742 kJ/mol

7) Why is HF not a strong acid?
   1) HF is purely covalent
   2) The electronegativity of H is too low
   3) H – F has no resonance
   4) HF is highly polarized and has an extremely short bond length
   5) None of the Above

8) Indicate the hybridization change of Sulfur during the following reaction
   SF₄ + 2H₂O → SO₂ + 2HF
   1. sp³d to sp²
   2. sp to sp³
   3. sp⁴ to sp²
   4. sp³ to sp
   5. None of the Above
9) Valence Bond Theory is extremely important because it….

1. Explains how molecular orbitals form
2. Shows people the electron density of all molecules
3. Disproves Hund’s Rule
4. Explains that a covalent bond forms when two atomic orbitals overlap
5. None of the Above

10) Which of the following molecules is not necessarily polar?
   (1) CF₂I₂  (2) Br₂XeI₂  (3) NH₃  (4) CH₃F  (5) SO₂

11) How many sigma (σ) and pi (π) bonds are found in CH₃CH₂CH₂CHCHCH₂COOH?
   (1) 22 σ and 1 π  (2) 20 σ and 2 π  (3) 20σ and 3 π  (4) 14 σ and 2 π  (5) 20 σ and 1 π

12) What respective type of hybridization is shown by the central atoms in CHF₃ and XeF₃⁺?
   (1) sp², sp²  (2) sp³, sp³  (3) sp², sp³d  (4) sp³, sp³d  (5) sp³, sp³d²
13) Which of the following is true regarding molecular orbital theory?

1. Antibonding orbitals have no effect on bond order
2. Molecular orbitals are hybridizations of atomic orbitals
3. Molecular orbital theory can be used to predict the relative stability of molecules
4. Molecular orbital theory cannot be used to predict the magnetic properties of molecules
5. The overlap of p orbitals always forms pi bonds

14) In which of the following is it necessary to use an expanded octet to represent a Lewis structure which has a zero formal charge of the central atom?
I. SO$_4^{2-}$  II. SeO$_2$  III. CO$_3^{2-}$  IV. PO$_4^{3-}$  V. SO$_3$

(1) I and II only
(2) III, IV, and V only
(3) I, II, IV, and V only
(4) IV and V only
(5) V only

15) In molecular orbital treatment of diatomic molecules, what type of molecular orbital(s) are created by mixing an s orbital from one atom with a p orbital from the other atom?

(1) only $\sigma$  (2) only $\pi$  (3) $\sigma$ and $\pi$  (4) $\sigma$ and $\sigma^*$  (5) $\pi$ and $\pi^*$
16) Which of the following is false?

1. Melting points decrease down a group because the larger metals have weaker attractions
2. Melting points stay the same across a period
3. Metals are good conductors of electricity as both solids and liquids
4. Metals are good conductors of heat due to mobile electrons
5. None of the Above

17) Why can some atoms break the octet rule?

1. The atom expands its inner shells to form more bonds
2. The atom is able to absorb energy and make itself available to more electrons
3. The central atom is large and can hold additional valence shells
4. The atoms need to access the d orbitals
5. None of the Above

18) Why is BF₃ not tetrahedral electron group geometric? I.e. why does it not have four bonds?

1. Boron has an expanded octet
2. The inner shell of Boron is too small
3. The Boron is similar to Beryllium which has metallic properties so it doesn’t want to form covalent bonds
4. The Boron has four electrons and one must be in the inner shell
5. None of the Above

19) Why do metals dent and not crack?

1. They have incredible electronegativity
2. The metal ions repel each other
3. The metal ions slide through a sea of electrons and end up in new positions
4. The metals have strong interionic repulsive properties
5. None of the Above
20) Which of the following is true?

1. Bond angle increases as lone pairs around central atom increases
2. Ideal molecular structures are never polar
3. All molecules with lone pairs around the central atoms are polar
4. Electron Group geometry is the Imperial version of molecular geometry
5. None of the Above

GOOD LUCK AND SMILE ON THE EXAM!
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