Question 1

Using the molecular orbital energy diagrams below, which one of the following diatomic molecules is LEAST likely to exist?

\[ \begin{align*}
\text{Small 2s-2p interaction (O}_2, \text{F}_2, \text{Ne}_2) & \\
\text{Large 2s-2p interaction (B}_2, \text{C}_2, \text{N}_2) & \\
\end{align*} \]

A. Li\_2  
B. Be\_2  
C. B\_2  
D. C\_2  
E. N\_2  
F. O\_2

Question 2

Using the molecular orbital energy diagrams below, which one of these molecules has unpaired electrons?

\[ \begin{align*}
\text{Small 2s-2p interaction (O}_2, \text{F}_2, \text{Ne}_2) & \\
\text{Large 2s-2p interaction (B}_2, \text{C}_2, \text{N}_2) & \\
\end{align*} \]

A. C\_2  
B. N\_2  
C. F\_2  
D. O\_2  
E. Li\_2
QUESTION 3

Using the molecular orbital energy diagrams below, what is the bond order of the H–H bond in the H$_2^+$ ion?

A. 0
B. 1/2
C. 1
D. 3/2
E. 2

QUESTION 4

Using the molecular orbital energy diagrams below, what is the bond order of OF$^-$ and how many unpaired electrons are there in the ion?

<table>
<thead>
<tr>
<th>Bond Order</th>
<th>Number of unpaired electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>1</td>
</tr>
<tr>
<td>B.</td>
<td>0</td>
</tr>
<tr>
<td>C.</td>
<td>2</td>
</tr>
<tr>
<td>D.</td>
<td>1</td>
</tr>
<tr>
<td>E.</td>
<td>2</td>
</tr>
</tbody>
</table>

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QUESTION 5

How does molecular orbital theory correctly predict the paramagnetism of liquid oxygen, $\text{O}_2$?

A. The bond order in $\text{O}_2$ can be shown to be equal to 2.
B. There are more electrons in the bonding orbitals than in the anti-bonding orbitals.
C. The energy of the two $p_{2p}$ MOs is higher than that of the $s_{2p}$ MO.
D. There are two unpaired electrons in the MO electron configuration of $\text{O}_2$.
E. The O–O bond distance is relatively short.

QUESTION 6

Which of these orbitals are anti-bonding molecular orbitals?

A. I
B. II
C. III
D. I and II
E. II and III
F. II, III, and IV
G. I, III and IV

QUESTION 7

What are the important intermolecular forces acting in liquid methanol, $\text{CH}_3\text{OH}$?

A. London dispersion forces only
B. London dispersion forces
C. dipole-dipole interactions and London dispersion forces
D. H-bonding, dipole-dipole interactions and London dispersion forces
E. ionic bonding
QUESTION 8
Which of the following atoms would you expect to be most polarizable?

A. O  
B. S  
C. P  
D. Se  
E. Te  

QUESTION 9
Predict the order of boiling points of the following substances: GeBr₄, SiH₄, CH₄, GeCl₄, SiCl₄.

A. CH₄ < SiCl₄ < SiH₄ < GeBr₄ < GeCl₄  
B. GeBr₄ < GeCl₄ < SiCl₄ < SiH₄ < CH₄  
C. SiH₄ < SiCl₄ < CH₄ < GeCl₄ < GeBr₄  
D. CH₄ < SiH₄ < SiCl₄ < GeCl₄ < GeBr₄  
E. GeCl₄ < GeBr₄ < SiH₄ < SiCl₄ < CH₄  

QUESTION 10
Noble gases such as argon and neon form soft, very low melting solids. What kind of interactions maintain the structures of these solids?

A. London Dispersion forces  
B. Dipole dipole forces  
C. Hydrogen bonds  
D. Covalent bonds  
E. Metallic bonds  

QUESTION 11
What kinds of attractive forces exist between particles in molecular crystals?

A. metallic bonds  
B. Van der Waal forces (intermolecular forces)  
C. Ionic bonds  
D. Covalent bonds  
E. Gravity  

QUESTION 12
You are given a white substance that sublimes at 3000°C without melting. The solid is a nonconductor of electricity and is insoluble in water. Which type of solid is this substance likely to be?

A. metallic solid  
B. molecular solid  
C. plastic  
D. ionic solid  
E. network covalent solid  

QUESTION 13
Which type of crystalline solid is has a high melting point, is brittle and is usually water-soluble?

A. a metallic solid  
B. a molecular solid  
C. a plastic  
D. an ionic solid  
E. a network covalent solid
**QUESTION 14**

Silicon carbide, SiC, forms one of the hardest crystals known because it is which of the following?

A. A metallic solid  
B. A molecular solid  
C. A plastic  
D. An ionic solid  
E. A network covalent solid

**QUESTION 15**

Which of the following is a good conductor of electricity in one of its pure elemental forms?

A. C  
B. Si  
C. P  
D. S  
E. B

**QUESTION 16**

Which one of the following statements is true?

A. A typical band-gap energy for a semiconductor is 400 kJ/mol. 
B. The conduction band is higher in energy than the valence band. 
C. Electrons can conduct well if they are in a filled valence band. 
D. Holes refer to empty atomic sites in a solid crystal. 
E. Most metals act as insulators.

**QUESTION 17**

What is true about silicon-based semi-conductors?

A. They have overlapping conduction and valence bands. 
B. They have a large energy gap between the conduction and valence bands. 
C. Those that are doped with phosphorus are electron deficient. 
D. Those that are doped with boron are electron deficient. 
E. None of the above answers concerning these semiconductors is correct.

**QUESTION 18**

Which one of the following materials can be classified as an insulator?

A. GaN  
B. C (diamond)  
C. ZnO  
D. Pb  
E. Sn

**QUESTION 19**

What do insulators typically have?

A. Insulators have the right number of valence electrons to make an electron pair bond between each pair of nearest neighbors in the crystal. 
B. Insulators have too many valence electrons to be accommodated by only the bonding orbitals. 
C. Insulators have a small energy gap between the conduction and valence bands. 
D. Insulators have higher coordination numbers than metals. 
E. Insulators have higher electronic and thermal conductivity than metals.
QUESTION 20
If you want to dope GaAs to make an n-type semiconductor with an element to replace Ga, which element would you pick?
A. B  
B. Al  
C. Be  
D. Si  
E. P

QUESTION 21
Which one of the following is an example of an intermetallic compound?
A. steel  
B. brass  
C. bronze  
D. Cr₃Pt  
E. 14 carat gold

QUESTION 22
What is true about intermetallic compounds?
A. They can have varying ratios of elements in their molecular formulas.  
B. They contain nonmetals in spaces between metal atoms in a crystal lattice.  
C. They have a crystal lattice with some metal atoms replaced by other metal atoms.  
D. They are nonhomogeneous dispersions.  
E. They contain two different metals in definite composition.

QUESTION 23
Brass is a mixture of copper and zinc. What kind of alloy is it an example of?
I. substitutional alloy  
II. interstitial alloy  
III. solution alloy
A. I only  
B. II only  
C. III only  
D. both I and II  
E. both I and III