Advanced Theories of Bonding Sample Multiple Choice Questions Fall 2022

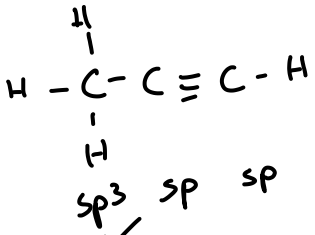
14/15

The number of sample questions does not reflect the number of questions that may appear on an In-term test.

1. In a Valence Bond description of bonding, the molecule $H_3C–C{\equiv}C–H$ has the following total number of hybridized orbitals:

   A. 2 B. 4 C. 6 (D.) 8 E. 10

   3s + sp



   sp^3 sp sp

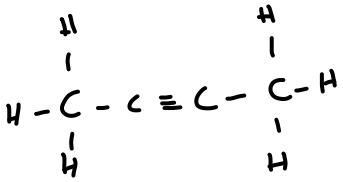
2. Which of the following statements is/are CORRECT for metallic bonding?

   i) Bonding electrons in metals are free to move from one bonding region to another. ✓
   ii) Bonding theory for metals must include highly directional bonds as for molecules. ?
   iii) The energy gap (band gap) between occupied and unoccupied molecular orbitals is largest for an insulator. ✓
   iv) There are no antibonding molecular orbitals for a semiconductor. ✗

   A. i only B. i and ii C. ii and iii (D.) i and iii E. ii and iv

3. Butyne, $H_3C–C{\equiv}C–CH_3$, has how many sigma (σ) and how many pi (π) bonds?

   A. 8 σ, 0 π B. 5 σ, 1 π C. 5 σ, 3 π (D.) 9 σ, 2 π E. 6 σ, 2 π

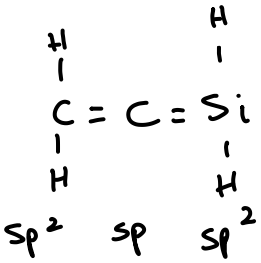


   9σ + 2π

4. What is the orbital hybridization assigned to the two C atoms and the Si atom in the molecule below, in order from left to right?

   $H_2C=C=SiH_2$

   A. sp^2, sp, sp^3
   B. sp^3, sp, sp^2
   C. sp^2, sp^2, sp^2
   D. sp, sp, sp^2
   (E.) sp^2, sp, sp^2



   sp^2 sp sp^2

5. Using bond enthalpies (given as Average Bond Energies in the Data Sheet) estimate the enthalpy change (ΔH, heat of reaction), in kJ mol^{-1}, for the following gas-phase reaction. (The bond energy value for S–C is 259 kJ mol^{-1} and that for S–H is 339 kJ mol^{-1}.)

   C–F = 485
   H–F = 565

   $HS–CH_2CH_2–SH + 2\,HF \rightarrow F–CH_2CH_2–F + 2\,HSH$

   A. +824 kJ (B.) 0 kJ C. –824 D. –160 E. +160

   Σ bonds broken − Σ bonds formed

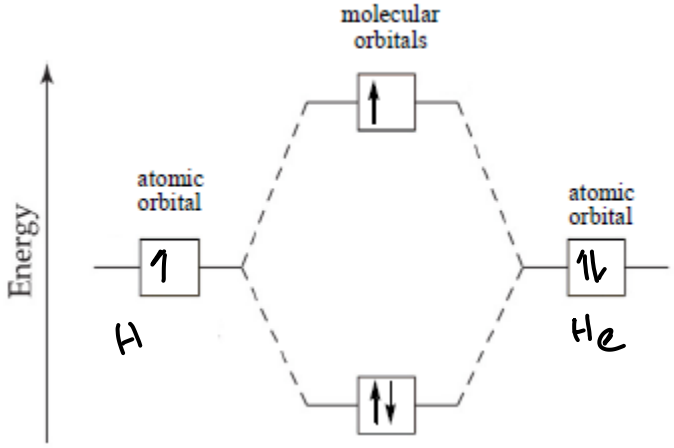
   $(2\times259 + 2\times565) - (2\times339 + 2\times485) = 0$

Advanced Theories of Bonding Sample Multiple Choice Questions Fall 2022

6. Which of the following statements is INCORRECT?

A. The bonding in a linear arrangement of electron regions can often be rationalized using sp hybrid orbitals.
B. When assigning the orbital hybridization, only bonding electrons are considered, since lone pairs do not participate in hybridization.
C. In the molecule $H_2C{=}O$ the H−C−O bond angles are slightly greater than 120°.
D. Double bonds take up more space than single bonds.
E. In NF_3 there are bond angles that are slightly less than the regular tetrahedral angle of 109.5°.

7. Consider the following molecular orbital energy diagram, which applies to diatomic species that use only 1s orbitals.



The MO diagram shown above can represent the electron energy levels for which of the following real or hypothetical molecule(s) or ion(s)?

i. H_2^- ii. He_2^+ iii. He_2^- iv. HHe v. H_2

A. i only B. ii only C. iv only D. i, ii and iv E. ii, iii and iv

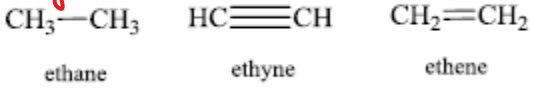
Advanced Theories of Bonding Sample Multiple Choice Questions Fall 2022

8. Tungsten (W) has the highest melting point of all the pure metals (3422 °C). Using your knowledge of metallic bonding, choose the best explanation for this fact from the selection below.

A. Tungsten has electrons in the 5d subshell.
B. Tungsten's molecular orbitals form a continuous band.
C. Tungsten has a half-filled s-d molecular orbital band, so the bonding between atoms is of maximum strength.
D. Tungsten has as many anti-bonding electrons as bonding electrons, so the bonding between atoms is of maximum strength.
E. Tungsten has a large first ionization energy, so it will not form an ionic lattice.

9. Consider the following molecules which contain carbon-carbon bonds: ethane (C_2H_6), ethyne (C_2H_2), and ethene (C_2H_4). The correct ordering in terms of carbon-carbon bond length is: (Where A>B means the carbon-carbon bond in A is longer than that in B.)

longest shortest shorter



ethane ethyne ethene

A. ethyne > ethene > ethane
B. ethyne > ethane > ethene
C. ethene > ethyne > ethane
D. ethane > ethyne > ethene
E. ethane > ethene > ethyne

10. Which experimental observation of the O_2 molecule can NOT be explained by simple valence bond theory, and requires instead the application of molecular orbital (MO) theory?

A. That it exhibits an oxygen-oxygen double bond
B. That it has a sigma (σ) bond and a pi (π) bond
C. That the oxygen-oxygen distance is shorter than a single bond
D. That liquid oxygen is attracted to the poles of a strong magnet
E. That oxygen is non-polar

Advanced Theories of Bonding Sample Multiple Choice Questions Fall 2022

11. Using average bond energies from the data sheet calculate the enthalpy change ΔH for the following reaction (in kJ). You may assume all reactants and products are gases.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

4 C–H 2 O=O 2 C–O 4 H–O

A. −1321 B. −521 C. −26 D. −48 E. −826

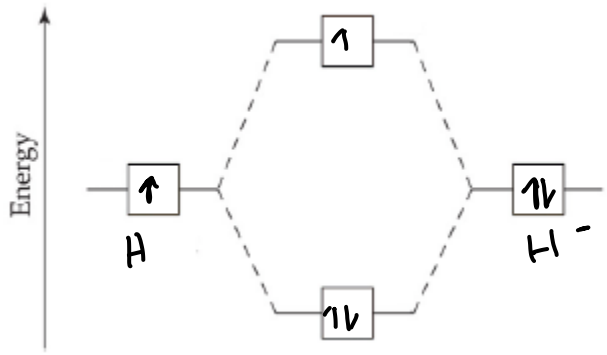
$(4 \times 413 + 2 \times 495) - (2 \times 800 + 4 \times 467) = -826$

12. Predict which of the following metals will have the highest melting point.

A. Cs B. Ba C. Ir D. Ta E. Au

↑ closest to group 6

13. Use the following molecular orbital energy diagram to determine the bond order in the H_2^- anion.



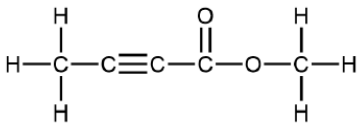
$B.O = \frac{1}{2}(2-1)$

$= \frac{1}{2}(1) = 0.5$

A. 0 B. 0.5 C. 1.0 D. 1.5 E. 2.0

14. How many sigma (σ) bonds and how many pi (π) bonds are there in the following molecule?

12 σ 3 π

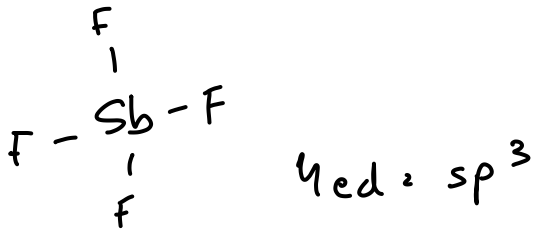


A. 10 σ, 2 π B. 10 σ, 3 π C. 10 σ, 5 π D. 12 σ, 2 π E. 12 σ, 3 π

Advanced Theories of Bonding Sample Multiple Choice Questions Fall 2022

15. What is the hybridization at antimony in $[SbF_4]^+$?

A. sp^3 B. sp^2 C. sp D. sp^3d E. sp^3d^2



Question	Answer
1	D
2	D
3	D
4	E
5	B
6	B
7	D
8	C
9	E
10	D
11	E
12	D
13	B
14	E
15	A