

Bonding Practice Problems

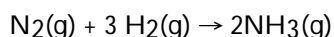
- 1) Which of the following statements is TRUE? 1) _____
- A) The Real World is still one of the best shows on television.
 - B) Energy is released when two like charged species are brought closer to one another.
 - C) Energy is given off when two oppositely charged species are separated.
 - D) The force between two ions is larger in water than in a vacuum.
 - E) The potential energy of oppositely charged particles decreases as they are brought closer together.

- 2) The distance between two atoms involved in a bond is 2) _____
- A) determined primarily by the size of the nuclei.
 - B) generally larger as the bond energies become larger.
 - C) always larger for double and triple bonds.
 - D) not related to bond energies.
 - E) the distance where the potential energy of the interaction is at a minimum.

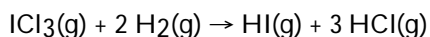
- 3) The dielectric constant of water is 3) _____
- A) roughly twice the dielectric constant of a vacuum
 - B) approximately one
 - C) approximately equal to the dielectric constant of a methanol solution
 - D) approximately zero
 - E) about 80 times greater than air or a vacuum

- 4) In which of the following molecules would you expect the nitrogen to nitrogen bond to be the shortest? 4) _____
- A) N_2H_2 B) N_2O_4 C) N_2H_4 D) N_2O E) N_2

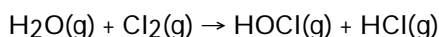
- 5) Given the following bond energies (in kJ/mol) $\text{N}\equiv\text{N}$ (946), $\text{H}-\text{H}$ (436), $\text{H}-\text{N}$ (389), estimate ΔH for the following reaction: 5) _____



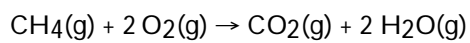
- 6) Given the following bond energies (in kJ/mol) $\text{I}-\text{Cl}$ (209), $\text{H}-\text{H}$ (435), $\text{H}-\text{I}$ (297), and $\text{H}-\text{Cl}$ (431), estimate ΔH for the following reaction: 6) _____



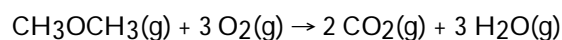
- 7) Given the following following bond energies (in kJ/mol) $\text{H}-\text{O}$ (464), $\text{Cl}-\text{Cl}$ (243), $\text{Cl}-\text{O}$ (205), and $\text{H}-\text{Cl}$ (431), estimate ΔH for the following reaction: 7) _____



8) Given the following bond energies (in kJ/mol) C=O (707), O=O (498), H—O (464), and C—H (414), estimate ΔH for the following reaction: 8) _____

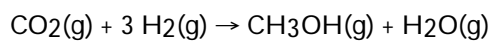


9) Given the following bond energies (in kJ/mol) C—O (360), C=O (707), O=O (498), H—O (464), C—H (414) estimate ΔH for the following reaction: 9) _____



10) Given the following bond energies (in kJ/mol) C—C (348), C=O (707), O=O (498), H—O (464), C—H (414) estimate ΔH for the complete combustion of heptane. 10) _____

11) Given the listed average bond energies, calculate the enthalpy change for the production of 48 g of methanol by the reaction: 11) _____



C—O	360 kJ/mol
C=O	736 kJ/mol
H—H	436 kJ/mol
H—O	464 kJ/mol
H—C	414 kJ/mol

12) Given the tabulated data, what is the lattice energy of crystalline calcium chloride? 12) _____

heat of sublimation for calcium	+178 kJ/mol
first ionization energy for calcium	+590 kJ/mol
second ionization energy for calcium	+1145 kJ/mol
heat of dissociation for chlorine	+122 kJ/mol(Cl)
electron affinity for chlorine	-349 kJ/mol
heat of formation for calcium chloride	-796 kJ/mol

13) Given the following information, calculate ΔH° (in kcal mole⁻¹) for: $\text{CaI}_2(\text{s}) \rightarrow \text{Ca}^{2+}(\text{g}) + 2 \text{I}^- (\text{g})$ 13) _____

<u>Process</u>	<u>ΔH° (kcal/mole)</u>
$\text{Ca}(\text{s}) \rightarrow \text{Ca}(\text{g})$	+178
$\text{I}_2(\text{g}) \rightarrow 2\text{I}(\text{g})$	+36 (per mole I_2)
$\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{g})$	+15
$\text{Ca}(\text{g}) \rightarrow \text{Ca}^+(\text{g}) + \text{e}^-$	+590
$\text{Ca}^+(\text{g}) \rightarrow \text{Ca}^{2+}(\text{g}) + \text{e}^-$	+1145
$\text{I}(\text{g}) + \text{e}^- \rightarrow \text{I}^-(\text{g})$	-71
$\text{Ca}(\text{s}) + \text{I}_2(\text{s}) \rightarrow \text{CaI}_2(\text{s})$	+534 (per mole CaI_2)

14) Given the following information, calculate ΔH° (in kcal mole⁻¹) for: $\text{I}(\text{g}) + \text{e}^- \rightarrow \text{I}^-(\text{g})$ 14) _____

<u>Process</u>	<u>ΔH° (kcal/mole)</u>
$\text{Ca}(\text{s}) \rightarrow \text{Ca}(\text{g})$	+178
$\text{I}_2(\text{g}) \rightarrow 2\text{I}(\text{g})$	+36 (per mole I_2)
$\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{g})$	+15
$\text{Ca}(\text{g}) \rightarrow \text{Ca}^+(\text{g}) + \text{e}^-$	+590
$\text{Ca}^+(\text{g}) \rightarrow \text{Ca}^{2+}(\text{g}) + \text{e}^-$	+1145
$\text{CaI}_2(\text{s}) \rightarrow \text{Ca}^{2+}(\text{g}) + 2 \text{I}^- (\text{g})$	+1288
$\text{Ca}(\text{s}) + \text{I}_2(\text{s}) \rightarrow \text{CaI}_2(\text{s})$	+534 (per mole CaI_2)

15) Given the tabulated data, what is the electron affinity for chlorine? 15) _____

heat of sublimation for calcium	+178 kJ/mol
first ionization energy for calcium	+590 kJ/mol
second ionization energy for calcium	+1145 kJ/mol
heat of dissociation for chlorine	+122 kJ/mol(Cl)
heat of formation for calcium chloride	-796 kJ/mol
lattice energy of crystalline calcium chloride	-2255 kJ/mol

- 16) The description of covalent bond formation as an overlap of atomic or hybrid atomic orbitals between the two bonded atoms is referred to as: 16) _____
- A) MOJO theory
 - B) atomic orbital theory
 - C) VSEPR method
 - D) molecular orbital theory
 - E) valence-bond theory
- 17) The concept of the anti-bonding orbital is unique to: 17) _____
- A) molecular orbital theory
 - B) bond hybridization theory
 - C) electrostatic repulsion theory
 - D) valence bond theory
 - E) pessimistic theory
- 18) What would you predict the bond order would be for the C-C bonds in benzene (C₆H₆)? 18) _____
- A) 0
 - B) 1
 - C) 3/2
 - D) 1/2
 - E) 2
- 19) Which statement is INCORRECT about molecular orbital theory? 19) _____
- A) The bonding orbitals are at a lower energy than antibonding orbitals.
 - B) Lower energy molecular orbitals are filled with electrons first.
 - C) Bond order = $\frac{(\# \text{ bonding } e^-) - (\# \text{ antibonding } e^-)}{2}$
 - D) The number of molecular orbitals formed is equal to the number of atomic orbitals combined.
 - E) Hund's rule does not apply in molecular orbital theory.
- 20) According to molecular orbital theory, when two atoms bond together, their *p* orbitals combine to form: 20) _____
- A) two sigma M.O.'s and two pi M.O.'s
 - B) four pi M.O.'s only
 - C) one sigma and one pi M.O.
 - D) two sigma M.O.'s and four pi M.O.'s
 - E) none of these
- 21) If a set of *p*-orbitals on two identical axes (*x*, *y*, *z*) are brought together along the *x*-axis, how many bonds can be formed that have no electron density along the axes? 21) _____
- A) 1
 - B) 4
 - C) 0
 - D) 2
- 22) Which of the following statements concerning the relative energy levels of molecular orbitals for the O₂ molecule is INCORRECT? 22) _____
- A) $\sigma_{2s} < \sigma_{2p}$
 - B) $\sigma_{2s} < \sigma^*_{2s}$
 - C) $\pi^*_{2p} < \sigma^*_{2p}$
 - D) $\pi_{2p} < \sigma_{2p}$
 - E) all of the above are correct

- 23) Which of the following molecules is paramagnetic? 23) _____
- A) C₂
 - B) B₂
 - C) N₂
 - D) F₂
 - E) none - all are diamagnetic

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

- 24) Molecular orbital theory describes covalent bonding as the overlap of partially filled atomic orbitals. 24) _____
- 25) Valence bond theory describes covalent bonding as the overlap of partially filled atomic orbitals. 25) _____
- 26) The best way to predict the magnetic properties of a molecule is to draw its lewis structure and look for any unpaired electrons. 26) _____
- 27) Molecular orbitals can be calculated by combining valence atomic orbitals using the linear combinations of atomic orbitals (LCAO) method. 27) _____
- 28) Because molecular orbital theory correctly explains observations that valence bond theory cannot, MO theory is better, and the use of VBT should be discouraged. 28) _____
- 29) Valence bond theory is widely used, useful and powerful theory that can be applied to a large number of molecules. However, it cannot explain all observations. 29) _____