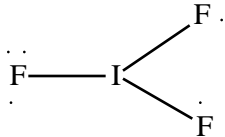
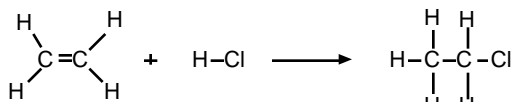


1. Consider the statements below:
- Mg is larger than Na
  - $\text{Na}^+$  is larger than  $\text{Mg}^{2+}$
  - $\text{Mg}^{2+}$  is larger than  $\text{O}^{2-}$
  - P is larger than O
- Which of these statements is/are correct?
- I and II
  - I, III, and IV
  - II and IV
  - II, III, and IV
  - I and IV
2. Place the following compounds in order of increasing magnitude of lattice energy: LiF, LiBr, NaI,  $\text{MgF}_2$ , MgO (that is, from least exothermic to most exothermic).
- LiF LiBr NaI  $\text{MgF}_2$  MgO
  - LiF LiBr NaI MgO  $\text{MgF}_2$
  - LiBr LiF MgO  $\text{MgF}_2$  NaI
  - NaI LiBr LiF MgO  $\text{MgF}_2$
  - NaI LiBr LiF  $\text{MgF}_2$  MgO
3. What are the two most important factors in determining the magnitude of the lattice energy of an ionic solid?
- electronegativity and polarity
  - ionization energy and electron affinity
  - ionic size and ionic charge
  - octet rule and resonance hybrid
4. Based upon a consideration of lattice energy, which compound below is expected to have the highest melting point? Which is expected to have the lowest melting point?
- NaCl MgO KBr
- |    | <u>Highest melting point</u> | <u>Lowest melting point</u> |
|----|------------------------------|-----------------------------|
| a. | KBr                          | MgO                         |
| b. | MgO                          | NaCl                        |
| c. | KBr                          | NaCl                        |
| d. | NaCl                         | KBr                         |
| e. | MgO                          | KBr                         |
5. Which types of elements are most likely to form binary ionic compounds?
- two metals
  - a metal and a nonmetal
  - two nonmetals
  - two elements with low electronegativity
  - two elements with high electronegativity
6. Which of the following bonds is the most polar?
- O-F
  - N-F
  - F-F
  - C-F
  - Cl-F
7. Which of the following compounds is best described as polar covalent?
- NaCl
  - $\text{Cl}_2$
  - $\text{CaF}_2$
  - HCl
8. Which of the following is a valid Lewis structure for the nitrite ion ( $\text{NO}_2^-$ )?
- $\text{O}-\text{N}-\text{O}$
  - $\text{O}=\text{N}=\text{O}$
  - $\text{O}=\text{N}-\text{O}:$
  - $\text{O} \equiv \text{N}-\ddot{\text{O}}$
  - $\ddot{\text{O}}=\ddot{\text{N}}=\ddot{\text{O}}$
9. Draw the Lewis structure for carbon monoxide, being careful to observe the octet rule. What is the formal charge on C and what is the formal charge on O (in that order)?
- +2, -2
  - +1, -1
  - 0, 0
  - 1, +1
  - 0, -1
10. How many electrons need to be added to the central atom in order to complete the Lewis electron-dot structure for iodine trifluoride,  $\text{IF}_3$ , illustrated below?
- 
- 2
  - 3
  - 4
  - 5
  - 6
11. Consider the nitrate anion. How many resonance structures can be drawn for nitrate in which all of the atoms obey the octet rule, and what is the formal charge on nitrogen in those resonance structures? (Note: N is the central atom.)
- 1 resonance structure; +1 formal charge on N
  - 2 resonance structures; +1 formal charge on N
  - 3 resonance structures; no formal charge on N
  - 3 resonance structures; +1 formal charge on N
  - 3 resonance structures; +2 formal charge on N
12. Consider the following resonance structures for  $\text{N}_2\text{O}$ , labeled **A**, **B**, and **C** below. Which resonance structure contributes most and which contributes least to the resonance hybrid? (Note: Formal charges and lone pair electrons are not shown.)
- $\text{N}=\text{N}=\text{O}$        $\text{N} \equiv \text{N}-\text{O}$        $\text{N}-\text{N} \equiv \text{O}$   
**A**                      **B**                      **C**

- a) A contributes most; B contributes least.  
 b) A contributes most; C contributes least.  
 c) B contributes most; A contributes least.  
 d) B contributes most; C contributes least.  
 e) C contributes most; B contributes least
13. Which of the following atoms is capable of violating the octet rule by having more than eight valence electrons?
- a) C  
 b) N  
 c) O  
 d) F  
 e) Cl
14. In which one of the following diatomic halogen molecules is the bond the shortest?
- a. F<sub>2</sub>  
 b. Cl<sub>2</sub>  
 c. Br<sub>2</sub>  
 d. I<sub>2</sub>
15. Use the table of bond energies to calculate  $\Delta H$  (in kJ) for the following gas phase reaction.



Bond	Bond Energy (kJ/mol)
C-C	348
C=C	614
C-H	413
H-Cl	431
C-Cl	328

- a. -44  
 b. 38  
 c. 304  
 d. 44  
 e. -475
16. Which hydrogen-halogen bond is predicted to be the weakest?
- a. H-F  
 b. H-Cl  
 c. H-Br  
 d. H-I
17. Use VSEPR to determine the geometries of the following molecules. Arrange these molecules in order of their bond angles, from the smallest bond angle to the largest bond angle: BF<sub>3</sub>, BrCl<sub>3</sub>, CCl<sub>4</sub>, PH<sub>3</sub>, SO<sub>2</sub>.
- a) CCl<sub>4</sub> < BrCl<sub>3</sub> < PH<sub>3</sub> < BF<sub>3</sub> < SO<sub>2</sub>  
 b) CCl<sub>4</sub> < BrCl<sub>3</sub> < BF<sub>3</sub> < PH<sub>3</sub> < SO<sub>2</sub>  
 c) BrCl<sub>3</sub> < PH<sub>3</sub> < CCl<sub>4</sub> < SO<sub>2</sub> < BF<sub>3</sub>  
 d) BrCl<sub>3</sub> < CCl<sub>4</sub> < PH<sub>3</sub> < BF<sub>3</sub> < SO<sub>2</sub>  
 e) PH<sub>3</sub> < SO<sub>2</sub> < BrCl<sub>3</sub> < CCl<sub>4</sub> < BF<sub>3</sub>

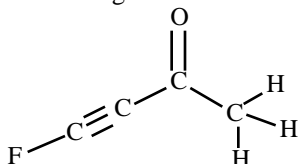
18. Which of the following species is/are expected to be square planar?
- I. XeF<sub>4</sub>  
 II. SO<sub>4</sub><sup>2-</sup>  
 III. SF<sub>4</sub>  
 IV. CCl<sub>4</sub>
- a) I only  
 b) I and II  
 c) II and III  
 d) II only  
 e) I, II, and IV
19. Based upon VSEPR, what is the expected bond angle in the ion ClBr<sub>2</sub><sup>-</sup>? (Cl is the central atom.)
- a) exactly 109.5°  
 b) slightly less than 109.5°  
 c) exactly 120°  
 d) slightly less than 120°  
 e) exactly 180°
20. What is the molecular geometry that VSEPR predicts for SeCl<sub>4</sub>?
- a) trigonal pyramidal  
 b) tetrahedral  
 c) square planar  
 d) see-saw  
 e) square pyramidal
21. The molecular structure of BrF<sub>5</sub> would best be described as:
- a) square pyramidal  
 b) see-saw  
 c) trigonal bipyramidal  
 d) tetrahedral  
 e) octahedral
22. Consider the molecule SF<sub>4</sub>. Which position is occupied by the lone pair of electrons on the central atom?
- a) equatorial  
 b) axial  
 c) tetrahedral  
 d) octahedral  
 e) planar
23. Which of the following molecules are polar?
- I. PF<sub>3</sub>  
 II. ClF<sub>5</sub>  
 III. H<sub>2</sub>O  
 IV. BF<sub>3</sub>
- a. I and III  
 b. III and IV  
 c. II and III  
 d. I, II, and III  
 e. I, II, III, and IV
24. How is the central atom (Xe) hybridized in XeF<sub>4</sub>?
- a) sp  
 b) sp<sup>2</sup>  
 c) sp<sup>3</sup>  
 d) sp<sup>3</sup>d  
 e) sp<sup>3</sup>d<sup>2</sup>

25. What is the Valence Bond Theory description of the bond between the two carbon atoms in acetylene,  $C_2H_2$ , shown below?



- a) three  $\pi$  bonds formed by the overlap of p orbitals  
 b) three  $\sigma$  bonds formed by the overlap of p orbitals  
 c) one  $\sigma$  bond formed by the overlap of  $sp^2$  orbitals, and two  $\pi$  bonds formed by the overlap of p orbitals  
 d) one  $\sigma$  bond formed by the overlap of sp orbitals, and two  $\pi$  bonds formed by the overlap of p orbitals  
 e) one  $\sigma$  bond formed by the overlap of  $sp^2$  orbitals, and two  $\pi$  bonds formed by the overlap of sp orbitals.

26. Consider the following molecule:

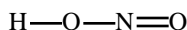


Which of the following correctly describes the hybridization of each carbon atom reading left to right?

- a)  $sp, sp^3, sp^2, sp^3$       d)  $sp^3, sp^3, sp^2, sp$   
 b)  $sp, sp^2, sp^2, sp^3$       e)  $sp, sp, sp^2, sp^3$   
 c)  $sp, sp^3, sp^2, sp$
27. Which of the following is best described as having a trigonal pyramidal molecular geometry?  
 a)  $ClF_3$       d)  $NO_3^-$   
 b)  $SO_3$       e)  $PCl_3$   
 c)  $CO_3^{2-}$
28. Which of the following correctly describes both the electron pair geometry and the molecular geometry of the ion  $ICl_2^-$ ?

	<u>Electron pair geometry</u>	<u>Molecular geometry</u>
a)	trigonal planar	bent
b)	trigonal planar	linear
c)	tetrahedral	bent
d)	trigonal bipyramidal	linear
e)	trigonal bipyramidal	bent

29. Consider the following bond angles in the molecule  $HNO_2$ :



Which of the following correctly identifies the approximate value of each bond angle?

	<u>H-O-N</u>	<u>O-N-O</u>
a)	$180^\circ$	$180^\circ$
b)	$120^\circ$	$109^\circ$
c)	$109^\circ$	$109^\circ$
d)	$109^\circ$	$120^\circ$
e)	$120^\circ$	$120^\circ$

30. Use molecular orbital theory to determine the electron configuration and bond order of the hypothetical molecule  $He_2$ .
- |    | electron configuration              | bond order |
|----|-------------------------------------|------------|
| a) | $(\sigma_{1s})^1 (\sigma_{1s}^*)^2$ | 1          |
| b) | $(\sigma_{1s})^2 (\sigma_{1s}^*)^1$ | 0          |
| c) | $(\sigma_{1s})^2 (\sigma_{1s}^*)^1$ | 0.5        |
| d) | $(\sigma_{1s})^2 (\sigma_{1s}^*)^2$ | 0.5        |
| e) | $(\sigma_{1s})^2 (\sigma_{1s}^*)^2$ | 0          |
31. What is the molecular orbital electron configuration of  $B_2$ ?
- a)  $(\sigma_{1s})^2 (\sigma_{1s}^*)^2 (\sigma_{2s})^2 (\pi_{2p})^4$   
 b)  $(\sigma_{1s})^2 (\sigma_{2s}^*)^2 (\sigma_{2p})^2 (\sigma_{2p}^*)^2 (\pi_{2p})^2$   
 c)  $(\sigma_{1s})^2 (\sigma_{1s}^*)^2 (\sigma_{2s})^2 (\sigma_{2p})^2 (\pi_{2p})^2$   
 d)  $(\sigma_{1s})^2 (\sigma_{1s}^*)^2 (\sigma_{2s})^2 (\sigma_{2s}^*)^2 (\sigma_{2p})^2$   
 e)  $(\sigma_{1s})^2 (\sigma_{1s}^*)^2 (\sigma_{2s})^2 (\sigma_{2s}^*)^2 (\pi_{2p})^2$
32. Determine the molecular orbital electron configuration of the  $C_2$  molecule. What is the bond order of  $C_2$ , and is  $C_2$  paramagnetic or diamagnetic?  
 a) The bond order is 2; it is diamagnetic.  
 b) The bond order is 3; it is paramagnetic.  
 c) The bond order is 4; it is diamagnetic.  
 d) The bond order is 1; it is paramagnetic.  
 e) The bond order is 1; it is diamagnetic.
33. Determine the molecular orbital electron configurations of  $O_2$ ,  $O_2^+$  and  $O_2^-$ . Which of these has the strongest bond, and which has the weakest bond?  
 a)  $O_2$  has the strongest bond;  $O_2^+$  has the weakest bond.  
 b)  $O_2$  has the strongest bond;  $O_2^-$  has the weakest bond.  
 c)  $O_2^+$  has the strongest bond;  $O_2^-$  has the weakest bond.  
 d)  $O_2^-$  has the strongest bond;  $O_2^+$  has the weakest bond.  
 e)  $O_2$  has the strongest bond;  $O_2^+$  has the weakest bond.

### Answers

1. c	11. d	21. a	31. e
2. e	12. d	22. a	32. a
3. c	13. e	23. d	33. c
4. e	14. a	24. e	
5. b	15. a	25. d	
6. d	16. d	26. e	
7. d	17. c	27. e	
8. c	18. a	28. d	
9. d	19. e	29. d	
10. c	20. d	30. e	