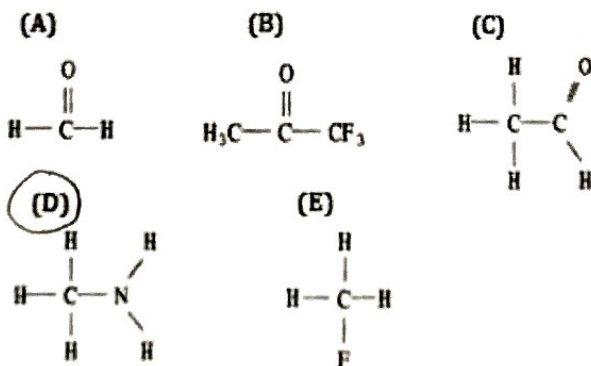


## Unit 9 Multiple Choice Practice

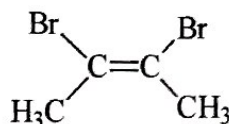
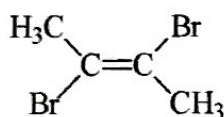
Hydrogen Halide	Normal Boiling Point, °C
HF	+19
HCl	-85
HBr	-67
HI	-35

1. The liquified hydrogen halides have the normal boiling points given above. The relatively high boiling point of HF can be correctly explained by which of the following?
- HF molecules tend to form hydrogen bonds.
  - HF is the strongest acid.
  - HF molecules have a smaller dipole moment.
  - HF is much less soluble in water.
2. Which of the following compounds would have the highest lattice energy?
- LiF
  - MgCl<sub>2</sub>
  - CaBr<sub>2</sub>
  - C<sub>2</sub>H<sub>6</sub>
3. Which one of the following substances will have hydrogen bonding as one of its intermolecular forces?



4. The substance with the lowest boiling point is \_\_\_\_\_.
- I<sub>2</sub>
  - Br<sub>2</sub>
  - Cl<sub>2</sub>
  - F<sub>2</sub>
5. Which of the following substances is an electrolyte when dissolved in water?
- CH<sub>3</sub>COOH
  - HCl
  - AsF<sub>3</sub>
  - SeF<sub>2</sub>
6. Which of the following pairs of elements is most likely to create an interstitial alloy?
- titanium and copper
  - aluminum and lead
  - silver and tin
  - magnesium and calcium

7. The relationship of the following two structures is



- a. resonance structures                      c. both isomers and resonance structures  
 b. isomers                                      d. neither isomers nor resonance structures

8. Given the following substances and their boiling points:

C: 43.8 °C

D: 93.7 °C

M: 56.7 °C

T: 83.5 °C

R: 63.6 °C

$\uparrow \text{BP} = \uparrow \text{IMF}$

Which ranking correctly lists some of these substances in order of decreasing intermolecular forces?

- a. C > R > D                                  c. R > M > D  
 b. D > T > R                                  d. C > D > M

D, T, R, M, C

9. When NaCl dissolves in water, aqueous  $\text{Na}^+$  and  $\text{Cl}^-$  result. The force of attraction that exists between  $\text{Na}^+$  and  $\text{H}_2\text{O}$  is called a(n) \_\_\_\_\_ interaction.

- a. Dipole – dipole                               d. Ion – dipole  
 b. Ion – ion                                      e. London dispersion force  
 c. Hydrogen bonding

10. Why does  $\text{CaF}_2$  have a higher melting point than  $\text{NH}_3$ ?

- a.  $\text{CaF}_2$  is more massive and thus has stronger London dispersion forces.  
 b.  $\text{CaF}_2$  exhibits network covalent bonding, which is the strongest type of bonding.  
 c.  $\text{CaF}_2$  is smaller and exhibits greater Coulombic attractive forces.  
 d.  $\text{CaF}_2$  is an ionic substance and it requires a lot of energy to break up an ionic substance.

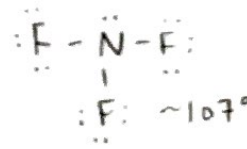
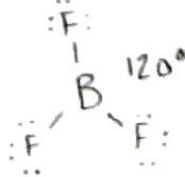
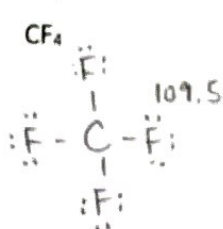
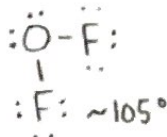
11. If X represents the central atom, which molecule has the largest F–X–F bond angle?

a.  $\text{OF}_2$

b.  $\text{CF}_4$

c.  $\text{BF}_3$

d.  $\text{NF}_3$



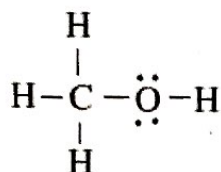
12. Why can a molecule with the structure  $\text{NBr}_5$  not exist?

- a. Nitrogen only has two energy levels and thus is unable to expand its octet.  
 b. Bromine is much larger than nitrogen and cannot be a terminal atom in this molecule.  
 c. It is impossible to complete the octet for all six atoms using only valence electrons.  
 d. Nitrogen does not have a low enough electronegativity to be the central atom of this molecule.

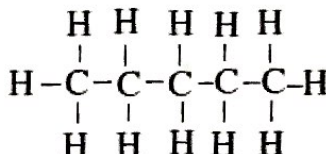
13. A sample of liquid  $\text{NH}_3$  is brought to its boiling point. Which of the following occurs during the boiling process?

- a. The N-H bonds within the  $\text{NH}_3$  molecules break apart.
- b. The overall temperature of the solution rises as the  $\text{NH}_3$  molecules speed up.
- c. The amount of energy within the system remains constant.
- d. The hydrogen bonds holding separate  $\text{NH}_3$  molecules together break apart.

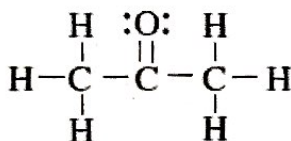
14. The following diagrams show the Lewis structures of four different molecules. Which molecule would be most soluble in a non-polar solvent?



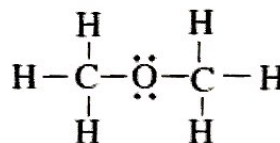
Methanol



Pentane



Acetone

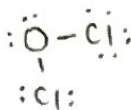


Ether

- a. methanol     b. pentane    c. acetone    d. ether

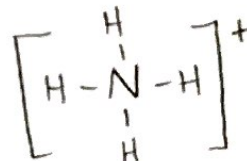
15. Which Lewis structure indicates the presence of two lone pairs of electrons on the central atom?

- a.  $\text{BeF}_2$     b.  $\text{NH}_3$      c.  $\text{OCl}_2$     d.  $\text{CH}_2\text{Cl}_2$



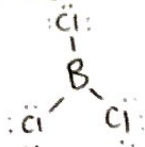
16. Which bond angle is present in the ammonium ion,  $\text{NH}_4^+$ ?

- a.  $90^\circ$     b.  $180^\circ$     c.  $120^\circ$      d.  $109.5^\circ$



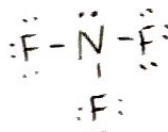
17. Which molecule is non-polar?

- a.  $\text{BCl}_3$     b.  $\text{NCl}_3$     c.  $\text{PCl}_3$     d.  $\text{CHCl}_3$



18. Predict the shape of a molecule of nitrogen trifluoride.

- a. bent    b. trigonal planar     d. trigonal pyramidal



19. Which molecule is polar?

a.  $\text{BCl}_3$  b.  $\text{NCl}_3$ c.  $\text{PCl}_5$ d.  $\text{CCl}_4$ 

20. Use VSEPR theory to predict the shape of carbon dioxide,  $\text{CO}_2$ .

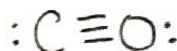
a. bent

b. trigonal planar

b. tetrahedral

 d. linear

21. What is the hybridization of the carbon atom in carbon monoxide,  $\text{CO}$ ?

 a.  $sp$ b.  $sp^2$ c.  $sp^3$ b.  $sp^3d$ 

22. All of the following molecules contain polar bonds. Of these molecules, the only one that is a non-polar molecule is:

a.  $\text{H}_2\text{O}$  b.  $\text{CO}_2$ c.  $\text{HCl}$ d.  $\text{NH}_3$ 

23. Which of the following compounds contains at least one element that violates the octet rule?

a.  $\text{OF}_2$ b.  $\text{NF}_3$ c.  $\text{CO}_2$  d.  $\text{H}_2\text{O}$ 

24. The six carbon atoms in a benzene molecule are shown in different resonance forms as three single bonds and three double bonds. If the length of a single carbon-carbon bond is 154 pm and the length of a double carbon-carbon bond is 133 pm, what length would be expected for the carbon-carbon bonds in benzene?

a. 126 pm

b. 133 pm

 c. 140 pm

d. 154 pm

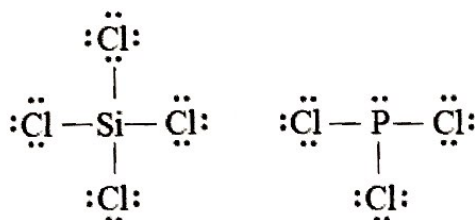
25. London dispersion forces are caused by

 a. temporary dipoles created by the position of electrons around the nuclei in a molecule

b. the three-dimensional intermolecular bonding present in all covalent substances

c. the uneven electron-to-proton ratio found on the individual atoms of a molecule

d. the electronegativity differences between different atoms in a molecule

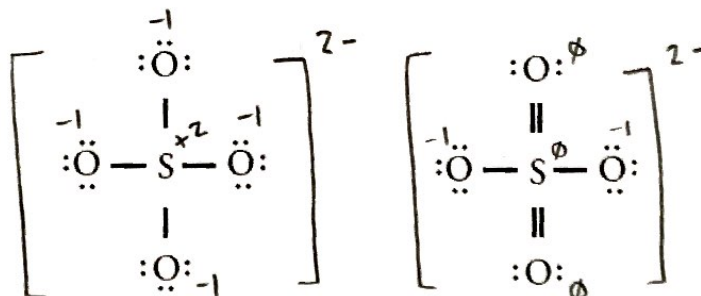


26. The Lewis diagrams for  $\text{SiCl}_4$  and  $\text{PCl}_3$  are drawn above. What are the approximate bond angles between the terminal chlorine atoms in each structure?

	$\text{SiCl}_4$	$\text{PCl}_3$
(A)	$90^\circ$	$90^\circ$
(B)	$109.5^\circ$	$< 109.5^\circ$
(C)	$90^\circ$	$109.5^\circ$
(D)	$< 109.5^\circ$	$> 90^\circ$

Use the following Lewis diagrams to answer questions 27–29.

There are several potential different Lewis electron-dot structures for the sulfate ion, two of which are below.



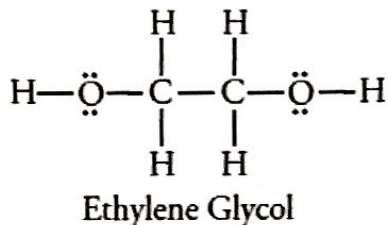
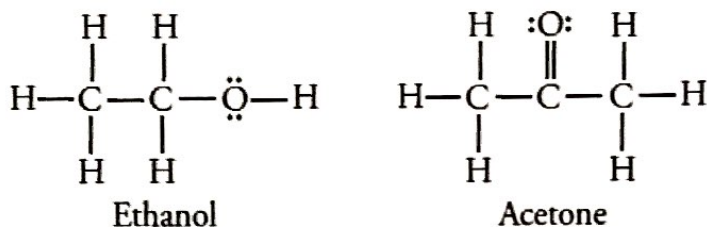
Structure A

Structure B

27. What is the molecular geometry in the structure A?
- octahedral
  - trigonal planar
  - tetrahedral
  - trigonal pyramidal
28. What is the S–O bond order in structure B?
- 1.0
  - 1.33
  - 1.5
  - 1.67
29. Which structure is more likely to correspond with the actual Lewis diagram for the sulfate ion?
- Structure A; single bonds are more stable than double bonds
  - Structure A; it has the most unshared pairs of electrons
  - Structure B; there are more possible resonance structures
  - Structure B; fewer atoms have formal charges

Use the following Lewis diagrams to answer questions 30–32.

The following three substances are kept in identical containers at 25°C. All three are in the liquid phase.

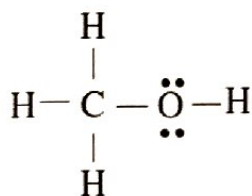


30. Which substance would have the highest boiling point?
- Ethanol, because it is most asymmetrical.
  - Acetone, because of the double bond.
  - Ethylene glycol, because it has the most hydrogen bonding.
  - All three substance would have very similar boiling points because their molar masses are similar.
31. Which substance would have the highest vapor pressure?
- Ethanol, because of the hybridization of its carbon atoms.
  - Acetone, because it exhibits the weakest intermolecular forces.
  - Ethylene glycol, because it has the most lone pairs assigned to individual atoms.
  - All three substance would have very similar vapor pressure because they have a similar number of electrons.
32. Which of the substances would be soluble in water?
- Ethylene glycol only, because it has the longest bond lengths.
  - Acetone only, because it is the most symmetrical.
  - Ethanol and ethylene glycol, because of their hydroxyl (-OH) group
  - All three substance would be soluble in water due to their permanent dipoles.

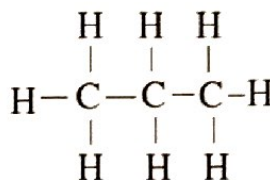
33. Which of the following has a ~~zero~~ <sup>non-polar</sup> dipole moment of zero?

- a. PF<sub>5</sub>      b. HCN      c. SO<sub>2</sub>      d. NH<sub>3</sub>

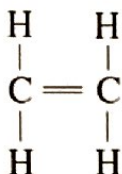
Questions 34–36 refer to the following structures.



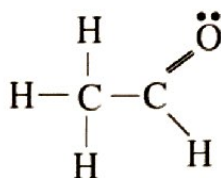
Methanol



Propane



Ethene



Ethanal

34. Based on the strength of the intermolecular forces in each substance estimate from greatest to smallest the vapor pressures of each substance in liquid state at the same temperature.
- Propane > Ethanal > Ethene > Methanol
  - Ethene > Propane > Ethanal > Methanol
  - Ethanal > Methanol > Ethene > Propane
  - Methanol > Ethanal > Propane > Ethene
35. When in liquid state, which two substances are most likely to be miscible with water?
- Propane and ethene
  - Methanol and propane
  - Ethene and ethanal
  - Methanol and ethanal
36. Between propane and ethene, which will likely have the higher boiling point and why?
- Propane, because it has a greater molar mass
  - Propane, because it has a more polarizable electron cloud.
  - Ethene, because of the double bond.
  - Ethene, because it is smaller in size.
37. The bond length between any two nonmetal atoms is achieved under which of the following conditions?
- Where the energy of interaction between the atoms is at its minimum value
  - Where the nuclei of each atom exhibit the strongest attraction to the electrons of the other atom
  - The point at which the attractive and repulsive forces between the two atoms are equal
  - The closest point at which a valence electron from one atom can transfer to the other atom.

Use the following information to answer questions 38–41.

Consider the Lewis structures for the following molecules:



38. Which molecule would have the shortest bonds?

- a.  $\text{CO}_3^{2-}$       b.  $\text{NO}_2^-$       c.  $\text{CO}_2$       d.  $\text{NO}_3^-$

39. Which molecules are best represented by multiple resonance structures?

- a.  $\text{CO}_3^{2-}$  and  $\text{NO}_3^-$       c.  $\text{CO}_2$  and  $\text{CO}_3^{2-}$   
 b.  $\text{CO}_3^{2-}$ ,  $\text{NO}_2^-$  and  $\text{NO}_3^-$       d.  $\text{NO}_2^-$  and  $\text{NO}_3^-$

40. Which molecule or molecules exhibit  $sp^2$  hybridization around the central atom?

- a.  $\text{CO}_3^{2-}$  and  $\text{NO}_3^-$       c.  $\text{CO}_2$  and  $\text{CO}_3^{2-}$   
 b.  $\text{CO}_3^{2-}$ ,  $\text{NO}_2^-$  and  $\text{NO}_3^-$       d.  $\text{NO}_2^-$  and  $\text{NO}_3^-$

41. Which molecule would have the smallest bond angle between terminal atoms?

- a.  $\text{CO}_3^{2-}$       b.  $\text{NO}_2^-$       c.  $\text{CO}_2$       d.  $\text{NO}_3^-$