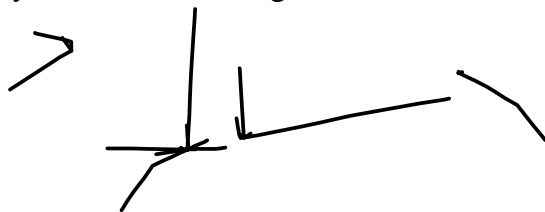


1. A central atom bonded to two other atoms and having no lone electron pairs would be expected to have a bond angle of a) 90° b) 120° c) 109° d) 180° e) 60°
2. Which set consists entirely of molecules that would exhibit **no** hydrogen bonding?
a) PH_3 , HCl , N_2H_4 b) OF_2 , HF , IF_3 c) H_2O , NH_3 , CH_3OH
d) CH_4 , H_2Se , BeH_2
3. Which exhibits resonance, or delocalization of π bonds? a) N_2 b) NO_2^-
c) C_2H_2 d) $\text{CH}_3\text{CH}=\text{CHCH}_3$ e) H_2S
4. In the compound shown to the right, what type(s) of hybridization are assigned to the carbon? a) sp^3 only b) sp^3 and sp^2
c) sp^3 and sp d) sp^2 and sp e) sp^2 only



Questions 5 to 10 use the following choices:

- A) Bent B) Trigonal Pyramid C) Trigonal Planar D) Tetrahedral E) Linear

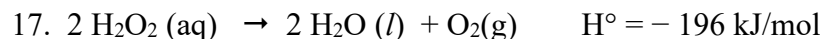
What is the geometry of each of the following molecules and ions?

5. BCl_3 6. PF_3 7. NO_3^- 8. NH_4^+ 9. SO_2 10. HCN

11. Which has a dipole moment of zero? A) NO B) SO_2 C) NH_3 D) H_2S E) C_6H_6 (benzene)
12. The Lewis structure of which of the following molecules shows only one unshared (lone) pair of valence electrons? A) Cl_2 B) N_2 C) NH_3 D) CCl_4
13. Which of the following has the greatest dipole moment? A) SO_3 B) BCl_3 C) CO_2 D) CH_3Cl
14. Which of these has a square planar shape? A) ICl_4^- B) CH_3Cl C) NH_4^+ D) SF_4
15. The electron pair geometry of the ion NO_2^+ is A) triangular B) bent C) tetrahedral D) linear
16. When the reaction $\text{C}_2\text{H}_{2(g)} + \text{Cl}_{2(g)} \rightarrow \text{C}_2\text{H}_2\text{Cl}_{2(g)}$ occurs, does the hybridization of the

carbon atoms change? A) Yes, from sp to sp^3 B) yes, from sp to sp^2 C)
yes, from sp^2 to sp^3 D) No, it does not change.

AP CHEMISTRY. We're Bonding! page



Assume that the bond enthalpies all of the O-H bonds are the same. Based on the value of ΔH° for the reaction provided above, which set of bond energies are possible? (in kJ/mol)

	O—O in H_2O_2	O=O in O_2	O—H
A)	150	500	500
B)	300	500	500
C)	500	300	150
D)	200	300	150

18 -21. Match the hybridization with that of the central atom in each of the following: molecules and ions.

A) sp B) sp^2 C) sp^3

18. NCl_2F (the nitrogen is central)

19. SO_2

20. HCN

21. SO_3

22. A cuvette containing a 0.40 molar solution of CuSO_4 (which is blue) is placed in a spectrophotometer, set at 635 nm. It shows an absorbance of 0.60. A cuvette containing a solution of CuSO_4 of unknown concentration in the same spectrophotometer, at the same wave length, has an absorbance of 0.45. What is the concentration of the unknown? A) 0.15 M B) 0.20 M C) 0.30 M D) 0.63 M

23. A sigma bond is A) concentrated along the internuclear axis B) formed by the side to side overlap of p orbitals C) formed by s orbitals only D) formed by p orbitals only

24. A pi bond is A) concentrated along the internuclear axis B) formed by s orbitals only
 C) formed by the side to side overlap of p orbitals D) formed by sp^2 hybrid orbitals

- 25 to 27. Choices: A) ionic bonding B) London forces C) Hydrogen bonding
 D) nonpolar covalent bonding E) polar covalent bonding

25. Explains why Xenon has a higher boiling point than Neon

26. Explains why alcohols, such as C_2H_5OH are liquids, while similarly sized hydrocarbons are gases at room temperature.

27. The bonding between the carbon and the oxygen in carbon dioxide.

28. Which of the following ionic crystals has the greatest lattice energy?

- A) KI B) NaBr C) $MgCl_2$ D) MgO

29. How many resonance structures are possible for the SO_3 molecule?

- A) none B) 2 C) 3 D) 4 E) 6

30. Which bond angle is LEAST likely in any simple molecule ?

- A) 90° B) 109° C) 120° D) 60° E) 180°

31. Which of the following is predicted to have the largest bond angle? A) H_2O B) BH_3
 C) NH_3 D) CH_4 E) SiH_4

Essays: Answer Questions I and II, plus two others, for a total of 4 essays. You may do a fifth one for extra credit.

I. a) Consider the carbon dioxide molecule, CO_2 , and the carbonate ion, CO_3^{2-} .

1) Draw complete Lewis electron dot diagrams for each species.

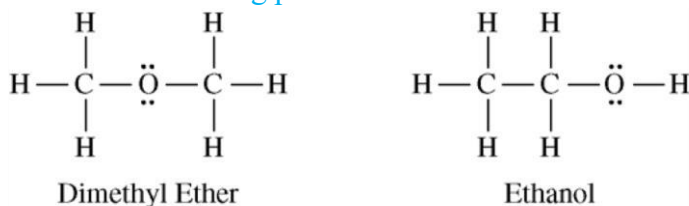
2) Compare the carbon-oxygen bond length in the two species, and explain any difference.

b) Consider the molecules CF_4 and SF_4 .

1) Draw the complete Lewis electron dot diagram for each molecule.

2) State whether each molecule is polar or nonpolar, and briefly explain your decision.

II. Structures of the dimethyl ether and ethanol molecules are shown below. The normal boiling point of dimethyl ether is 250 K, while the normal boiling point of ethanol is 351 K. Account for the difference in boiling points. You must discuss BOTH of the substances in your answer.



B. The normal boiling point of $\text{Cl}_2(l)$, 238 K, is **higher** than the normal boiling point of $\text{HCl}(l)$. (188 K) Account for the differences in normal boiling points based on the types of intermolecular forces in the substances. You must discuss **both** substances in your answer.

C. Xenon can react with oxygen and fluorine to form compounds such as XeO_3 and XeF_4 .

1. Draw the complete Lewis electron-dot diagram for each of these two molecules.
2. On the basis of the electron dot diagrams you drew for part 1, predict the following:
 - a) The geometric shape of the XeO_3 molecule
 - b) The geometric shape of the XeF_4 molecule
 - c) Predict whether the XeO_3 molecule is polar or nonpolar. Justify your prediction.

III. Consider the molecules PF_3 and PF_5

- a) Draw the Lewis electron dot structures of both molecules, and predict the molecular geometry of each.
- b) State whether each molecule is polar or nonpolar, and explain your answer.
- c) Explain why PF_5 exists, but NF_5 does not.
- d) Which is likely to have a higher boiling point - KCl or NaF ? Explain

IV. A. Draw the structure of the sulfite ion, SO_3^{2-} .

- 1) Find the formal charge on each atom in the structure you have drawn.
- 2) Indicate the geometry of the ion.
- 3) Which of the following bond angles are most likely for this ion? Explain your choice

a) 120° or b) 118° or c) 109° or d) 107°

V. Draw Lewis structures for each of the following species. In each case, indicate the total number of sigma bonds, and the total number of pi bonds in the molecule or ion.

