1. The geometry of the SO$_3$ molecule is best described at:
   (A) trigonal planar   (B) trigonal pyramidal   (C) square pyramidal
   (D) bent   (E) tetrahedral

2. Which of the following molecules has the shortest bond length?
   (A) N$_2$   (B) O$_2$   (C) Cl$_2$   (D) Br$_2$   (E) I$_2$

3. Pi($\pi$) bonding occurs in each of the following species except: (A) CO$_2$   (B) C$_2$H$_4$
   (C) CN$^-$   (D) C$_6$H$_6$   (E) CH$_4$

4. Which of the following has a zero dipole moment?  (A) HCN   (B) NH$_3$  (C) SO$_2$
   (D) NO$_2$   (E) PF$_5$

5. For which of the following molecules are resonance structures necessary
   to describe the bonding satisfactorily?  (A) H$_2$S   (B) SO$_2$   (C) CO$_2$
   (D) OF$_2$   (E) PF$_3$

Use the following choices to answer questions 6 and 7:  (A) hydrogen bonding
(B) hybridization   (C) ionic bonding   (D) resonance   (E) van der Waals forces

6. Is used to explain the fact that the four bonds in methane are equivalent.

7. Is used to explain the fact that the carbon-to-carbon bonds in benzene, C$_6$H$_6$,
   are identical.

8. The Lewis dot structure of which of the following molecules shows only one
   unshared pair of valence electrons?
   (A) Cl$_2$   (B) N$_2$   (C) NH$_3$   (D) CCl$_4$   (E) H$_2$O$_2$

9. The SbCl$_5$ molecule has a trigonal bipyramid structure. Therefore, the
   hybridization of Sb orbitals should be:  (A) sp$^2$   (B) sp$^3$   (C) sp$^2$d
   (D) sp$^3$d$^2$   (E) sp$^3$d$^2$

10. Which of the following does not describe any of the following molecules:
    CCl$_4$, CO$_2$, PCl$_3$, PCl$_5$, SF$_6$.  (A) Linear   (B) Octahedral   (C) Square Planar
    (D) Tetrahedral   (E) Trigonal Pyramidal
11. Which of the following compounds is ionic and contains both sigma and pi covalent bonds? (A) Fe(OH)$_3$ (B) HClO (C) H$_2$S (D) NO$_2$ (E) NaCN

**Use the following answers for questions 12-14:** (A) Li$_2$ (B) B$_2$ (C) N$_2$ (D) O$_2$ (E) F$_2$

12. Has the largest bond-dissociation energy.

13. Has the shortest bond length.

14. Contains 1 sigma and 2 pi bonds.

15. In a molecule in which the central atom exhibits sp$^3$d hybrid orbitals, the electron pairs are directed toward the corners of a: (A) tetrahedron (B) square-based pyramid (C) trigonal bipyramid (D) square (E) octahedron

16. Molecules that have planar configurations include which of the following: I. BCl$_3$ II. CHCl$_3$ III. NCl$_3$
   (A) I only (B) III only (C) I and II only (D) II and III only (E) I, II, and III

17. The electron-dot structure (Lewis structure) for which of the following molecules would have two unshared pairs of electrons on the central atom?
   (A) H$_2$S (B) NH$_3$ (C) CH$_4$ (D) HCN (E) CO$_2$

18. Which of the following has a dipole moment of zero?
   (A) C$_6$H$_6$ (B) NO (C) SO$_2$ (D) NH$_3$ (E) H$_2$S

**Use the following answers to answer questions 19-22:** (A) Lattice of positive and negative ions held together by electrostatic forces (B) closely packed lattice with delocalized electrons throughout (C) strong single covalent bonds with weak intermolecular forces (D) strong multiple covalent bonds with weak intermolecular forces (E) macromolecules held together with strong polar bonds

19. Cesium Chloride, CsCl(s)

20. Gold, Au(s)
21. Carbon Dioxide, CO$_2$(s)

22. Methane, CH$_4$(s)

23. Types of hybridization exhibited by the C atoms in propene, CH$_3$CHCH$_2$, include which of the following? I. sp  II. sp$_2$  III. sp$_3$
   (A) I only  (B) III only  (C) I and II only  (D) II and III only  (E) I, II, and III

24. Of the following molecules, which has the largest dipole moment?
   (A) CO  (B) CO$_2$  (C) O$_2$  (D) HF  (E) F$_2$

25. In which of the following processes are covalent bonds broken?
   (A) I$_2$(s) $\rightarrow$ I$_2$(g)  (B) CO$_2$(s) $\rightarrow$ CO$_2$(g)  (C) NaCl(s) $\rightarrow$ NaCl(l)
   (D) C(diamond) $\rightarrow$ C(g)  (E) Fe(s) $\rightarrow$ Fe(l)

For #26-28, refer to the following molecules.
   (A) CO$_2$  (B) H$_2$O  (C) CH$_4$  (D) C$_2$H$_4$  (E) PH$_3$

26.) The molecule with only one double bond

27.) The molecule with the largest dipole moment

28.) The molecule that has trigonal pyramidal geometry.

Answers
26 – D  27 – B  28 - E