

I. Short answer

- _____ 1. In which case should the carbon-nitrogen bond length be the shortest?
 A. $\text{H}_3\text{C}-\text{NH}_2$ B. $\text{H}_2\text{C}=\text{NH}$ C. $\text{HC}\equiv\text{N}$
- _____ 2. Which of the molecules in #1 should have the largest carbon-nitrogen bond energy?
- _____ 3. Which can have more than eight electrons in its outer shell in a molecule?
 A. Li B. Ne C. F D. Br E. N
- _____ 4. In which case does rotation about the carbon-carbon bond not occur readily?
 A. $\text{H}_2\text{C}=\text{CH}_2$ B. $\text{H}_3\text{C}-\text{CH}_3$ C. $\text{Cl}_3\text{C}-\text{CCl}_3$
- _____ 5. A molecule with polar covalent bonds must be a polar molecule. A. true B. false
- _____ 6. Which of the following molecules is likely to form hydrogen bonds?
 A. PH_3 B. NH_3 C. H_2 D. SO_2
- _____ 7. What are the intermolecular forces for nonlinear OF_2 ?
 A. London forces only B. dipole-dipole forces only
 C. both London and dipole-dipole forces D. neither London nor dipole-dipole forces
 E. London forces, dipole-dipole forces, and hydrogen bonding
- _____ 8. What are the intermolecular forces for F_2 ?
 A. London forces only B. dipole-dipole forces only
 C. both London and dipole-dipole forces D. neither London nor dipole-dipole forces
 E. London forces, dipole-dipole forces, and hydrogen bonding
- _____ 9. Consider two liquids, one polar and one nonpolar, with essentially the same molecular weight. Which should have the higher normal boiling point?
 A. the polar liquid B. the nonpolar liquid C. it should be the same for both
- _____ 10. Which should have the strongest intermolecular forces?
 A. F_2 B. Cl_2 C. Br_2 D. I_2
- _____ 11. In valence bond theory, π bonds are generally due to overlap involving
 A. hybrid atomic orbitals B. unhybridized p atomic orbitals C. unhybridized s atomic orbitals
12. Classify the bonding in each of the following as ionic (I), nonpolar covalent (NP), or polar covalent (PC). Write the charges (... 3+, 2+, 1+, 1-, 2-, 3-, ...) or partial charges (δ_+ , δ_-) above each atom. Make no mark above the atom if there is no charge or partial charge.

(a) Na_2S _____ (b) PCl_3 _____ (c) P_4 _____ (d) SO_3 _____ (e) FeF_3 _____

13. The breaking of chemical bonds _____ (requires, releases) energy.

14. C_2H_6 is considered _____ (polar, nonpolar).

15. Consider $\text{H}-\text{C}\equiv\text{N}$

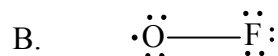
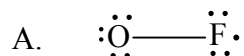
(a) The $\text{H}-\text{C}$ bond should be a/an _____ (σ , π) bond.

(b) The $\text{C}\equiv\text{N}$ bond should consist of _____ σ bond(s) and _____ π bond(s).

(c) The orbital hybridization of the C can be taken to be _____ (sp , sp^2 , sp^3 , sp^3d , sp^3d^2).

(d) Which atom(s) has/have lone pair electrons? _____ (H, C, N,).

16. Consider these two Lewis structures for OF. Calculate the formal charge on F and O.



formal charge on F _____

formal charge on F _____

formal charge on O _____

formal charge on O _____

Which is the preferred structure for OF? _____ (A, B)

OF should be _____ (diamagnetic, paramagnetic)

II. Lewis structures

1. Give preferred Lewis structure(s) for the following. If resonance should occur, include the major contributing structures. Circle your final answer(s).

(a) H_2S

(b) Na_2S

(c) O_3

(d) CS_2

(e) ICl_5

(f) PCl_3

(h) SO_3

(i) ICl_4^-

2. Circle those that should have a dipole moment: H_2S CS_2 ICl_5 PCl_3 SO_3

3. The formal charge on the central O in O_3 is _____

The orbital hybridization on the central O in O_3 can be taken to be _____ (sp , sp^2 , sp^3 , sp^3d , sp^3d^2).

The O-S-O bond angle in SO_3 should be _____ (90° , 109.5° , 120° , 180°)

Which should be smaller, the O-O-O bond angle in O_3 or the O-S-O bond angle in SO_3 , or neither?

Should the S-O bond lengths in SO_3 all be the same? _____ (yes,no)

4. Indicate the molecular shape (bent or angular, linear, octahedral, seesaw, square planar, square pyramidal, T-shaped, tetrahedral, trigonal bipyramidal, trigonal planar, trigonal pyramidal) for:

(a) H_2S _____

(b) O_3 _____

(c) CS_2 _____

(d) ICl_5 _____

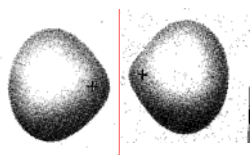
(e) PCl_3 _____

(f) SO_3 _____

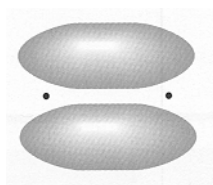
(g) ICl_4^- _____

III. Molecular orbitals

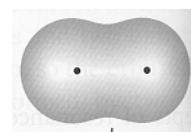
1. Consider the following three molecular orbitals.



A.



B.



C.

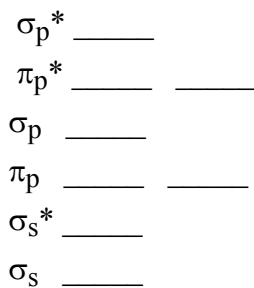
Orbital A is a _____ (bonding, antibonding) _____ (σ, π) molecular orbital.

Orbital B is a _____ (bonding, antibonding) _____ (σ, π) molecular orbital.

Orbital C is a _____ (bonding, antibonding) _____ (σ, π) molecular orbital.

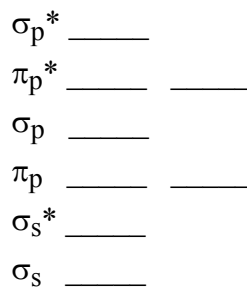
2. Fill in the molecular orbital diagrams below (valence electrons only) for Be_2 , B_2 , and C_2 .

(a) Be_2



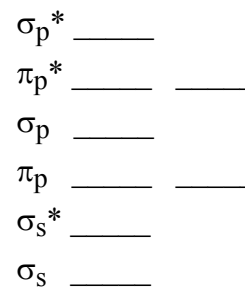
Bond order _____

(b) B_2



Bond order _____

(c) C_2



Bond order _____

Which one(s), if any, should be unstable? _____

Which one(s), if any, should be paramagnetic? _____

Scratch Sheet