Practice Test - Chapter 9 Name Key
Molecular Geometry and Bonding Theories Date _____ Period _____

I. MULTIPLE CHOICE: *Circle the letter that best completes each statement below. No calculators are allowed on this Practice Test!*

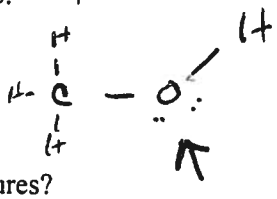
Target 1: I can determine the bond angle, geometric shape and the electron domain shape of a molecule or ion based upon the V.S.E.P.R. Theory.

B 1. Which of the following has a nonbonding pair of electrons on the central atom?

a. BCl_3 b. NH_3 c. CCl_2Br_2 d. PF_5 e. SO_4^{2-}

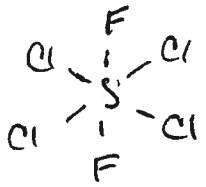
E 2. What is the approximate C-O-H bond angle in CH_3OH?

a) 180^o b) 120^o c) 109.5^o d) 90^o e) 105^o



D 3. Which one of the following may we draw both polar and nonpolar Lewis structures?

a. CHCl3
b. NH3
c. BF3
d. SF_2Cl_4
e. SO2



D 4. Which one of the following is NOT a linear structure?

a. I_2 b. I_3^- c. CO_2 d. H_2S e. $H-C\equiv C-H$

A 5. The Lewis structure of the cyanide ion most closely resembles which of the following?

a. N_2 b. O_2 c. CO_2 d. NO e. C_2H_2

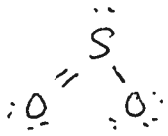
A 6. Which angle is NOT expected in any molecule?

a. 60°
b. 90°
c. 109.5°
d. 120°
e. All of these are reasonable angles.

Target 2: I can explain why nonbonding electron domains exert a greater repulsive interaction on other domains than do bonding electron domains.

B 7. Which molecule below would have the greatest repulsion of electrons resulting in the smallest bond angle.

a. BH_3 b. H_2O c. PH_3 d. SO_2 e. CH_4



Target 3: I can predict from the shape of a molecule whether it is polar or nonpolar.

C 8. Which of the bonds below is the most polar? (Review from Chapter 8)

Element	Si	H	C	S	N	O
electronegativity	1.8	2.1	2.5	2.5	3.0	3.5

a. C - Si b. C - N c. O - C d. S – C e. H - C

BCD 9. How many of the molecules below are polar. (Circle answers that are polar!)

a. BH_3 b. H_2O c. PH_3 d. SO_2 e. CH_4

E 10. Which one molecule below will have a zero dipole moment?

a. NH_3 b. NO_2 c. HCN d. SO_2 e. PF_5

Target 4: I can explain the concept of hybridization and its relationship to geometrical structure.

Target 5: I can predict the type of hybrid orbitals of an atom in a molecule.

C 11. The SF_5^- ion has a square pyramid structure. The hybridization of the orbitals in sulfur is:

a. dsp^3
b. sp
c. d^2sp^3
d. sp^3
e. sp^2

C 12. In which of the following pairs are the two items NOT properly related?

a. sp^3 and 109.5°
b. trigonal planar and 120°
c. octahedral and d^2sp^3
d. sp and 180°
e. spare planar and d^2sp^3

A 13. Sulfur forms the following compounds: SO_2, SF_6, SCl_4, SCl_2. Which form of hybridization is NOT represented by these molecules?

a. sp b. sp^2 c. sp^3 d. dsp^3 e. d^2sp^3

Target 6: I can explain the difference between a sigma bond and a pi bond. I can also determine the number of sigma bonds and pi bonds in a molecule or ion.

14. For # a - f, identify which statements below is a characteristic of a pi (p) or a sigma (s) bond.

S a. Formed by the head-to-head bond between atoms.

P b. Formed above and below the bond axis.

P c. A triple bond would contain two of these.

P d. This bonding occurs from the sideways overlap of an electron in p orbitals.

P e. A triple bond would contain two of these.

C 15. Which of the following has the fewest pi bonds and is nonpolar?

a. HCCH
b. CO_2
c. CO_3^{2-}
d. N_2
e. SO_2

A 16. Which one of the following is true when the C = C and C≡C bonds are compared?

a. The triple bond is shorter than the double bond.
b. The double bond contains more pi bonds.
c. The double-bond energy is higher than the triple-bond energy.
d. The double bond contains less sigma bonds.

Target 7: I can explain what delocalized electrons and the significance of a structure having delocalized electrons mean.

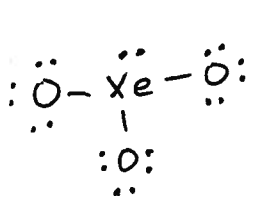
ABCD 17. Circle the following statements below that is(are) true about delocalized electrons.

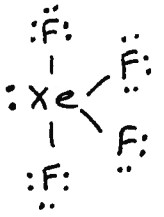
a. This may occur when structures have resonance of a double bond.
b. Benzene possesses delocalized which increase the strength of the bonds and elevates its boiling point.
c. They "stabilize" the molecule.
d. They are associated with pi bonding.
e. They are assicatiated with sigma bonding.

I. FREE RESPONSE: *Complete each of the following free response questoins kin the spaces provided.*

1. Answer the following questions about XeO_3 and XeF_4.

a. Xenon can react with oxygen and fluorine to form compounds such as XeO_3 and XeF_4 . Draw the complete Lewis electron-dot diagram for each of the molecules represented below.





b. On the basis of the Lewis electron-dot diagrams you drew for part (a), predict the following:

(i) The geometric shape of the XeO_3 molecule.

Trigonal pyramidal

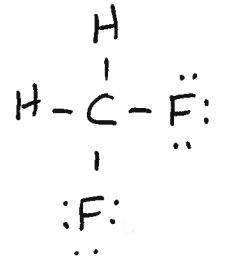
(ii) The hybridization of the valence orbitals of xenon in XeF4.

sp^3d

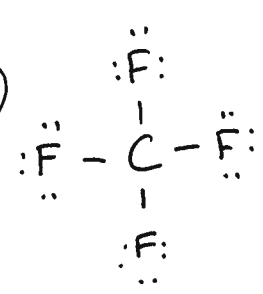
c. Predict whether the XeO_3 molecule is polar or nonpolar. Justify your prediction.

polar since lone pair of electrons on central atom

d. Explain why the CH_2F_2 molecule is polar, where the CF_4 molecule is not.

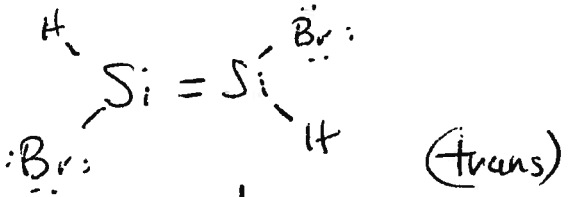


This is polar since H and F have different electronegativities and the electrons are not shared equally



This is non-polar because the pull on the central atom is equal from each fluorine atom

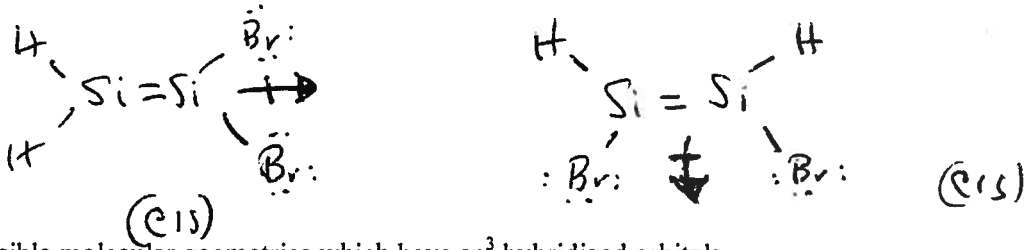
2. ***Daw the Lewis dot structure for a nonpolar molecule that has a molecular formula of $Si_2H_2Br_2$.***



a. There are 5 sigma bonds and 1 pi bond(s) in this molecule?

b. The hybridization around each carbon is sp^2, and the bond angle is 120°.
This molecule is nonpolar because it is symmetric and it has cancelled dipoles.

c. Draw the two polar isomers of this compound and indicate where the dipole is located.



3. List all possible molecular geometries which have sp^3 hybridized orbitals.

tetrahedral; trigonal pyramidal & bent

4. Identify the molecular shapes that are always polar.

Bent (sp^2) SO_2 | Bent (sp^3) NH_3 | See-saw, T-Shaped — sp^3d | Square pyramidal sp^3d^2

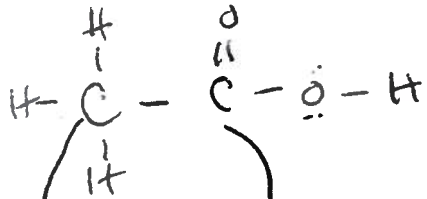
5.

Boiling point	Substance
231 K	C_3H_8
355 K	CH_3CN

With the information above suggest a reason why CH_3CN has a higher boiling point than C_3H_8

Ch. 11 polar ↳ Nonpolar

6 Draw the structure for acetic acid (H_3C-COOH) below. Then answer the following two questions. NOTE: The second carbon is double bonded to the first oxygen and single-bonded to the second O. The H is attached to the second oxygen.



a. What is the molecular geometry around each carbon atom?

tetrahedral trigonal planar

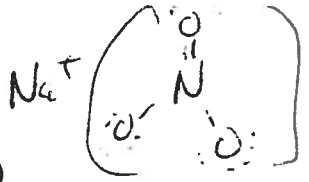
b. What type of hybrid orbitals does each carbon have?

sp^3 sp^2

9. The following chart reinforces the valence bond theory.

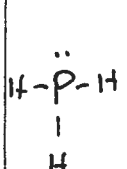
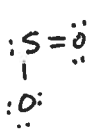
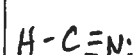
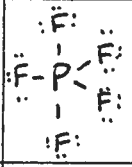
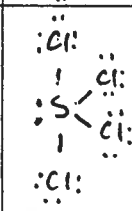
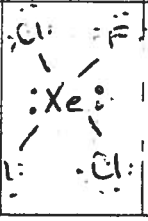
HO = hybridized orbital

Molecule or Ion	Overlap of orbitals forming the sigma bond between the central atom and the bonded atoms around it
PH_3	sp^3 (HO) on the P bonded w an s orbital on H
SO_2	sp^2 (HO) on the S bonded w/ a p orbital on O
HCN	sp (HO) on the C with an s orbital on the H. and a p orbital on the N
PF_5	sp^3d (HO) on the P with the p orbital on the F
SCl_4	sp^3d (HO) on the S with a p orbital on the Cl
$XeFCl_3$	sp^3d^2. HO on the Xe w/ a p orbital on both the F & Cl



7. Name a compound with both ionic and covalent bonds. $NaNO_3$ (ie.)

8. Name three elements which . . .
   a) cannot have expanded octets when it is the central atom in a molecule.
   C, N, B Caughthing in p. 2 or p1
   b) do not need an octet to form stable compounds.
   H, Be, B

Molecule or Ion	Structure	e- domain geometry	Molecular geometry or shape	Bonded / Nonbonded e- domains	Polar or Nonpolar	Hybridizaion	Bond Angle
PH_3		Tetra	Trig pyr	3/1	P	sp^3	107
SO_2		Trig plan.	bent	2/1	P	sp^2	117
HCN		linear	linear	2/0	P	sp	180
PF_5		Trig bipyr.	trig bipyr	5/0	NP	sp^3d	90/120
SCl_4		Trig bipyr	see saw	4/1	P	sp^3d	approx 90°
$XeFCl_3$ 8+28 32		octahedal	square planar	4/2	P	sp^3d^2	90°

8. Identify any molecules above that has pi bonding? SO_2, HCN

10. Following is a integrative problem using the mole concept and Chapters 8 and 9.

A compound consists of 61.70 %Cl 10.40 %C and 27.80 %S by mass. Knowing this determine the following.

a. What is the empirical formula(which is also the molecular formula) of this compound?

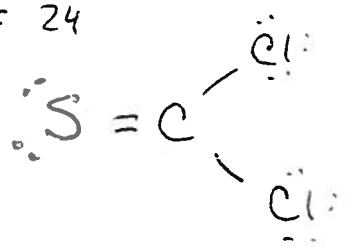
$$61.70\text{ g Cl} \left| \frac{\text{mol Cl}}{35.453\text{ g Cl}} \right. = 1.74 / .867 = 2$$

$$10.40\text{ g C} \left| \frac{\text{mol C}}{12\text{ g C}} \right. = .867 / .867 = 1 \quad \text{So ...}$$

$$27.80\text{ g S} \left| \frac{\text{mol S}}{32.06\text{ g S}} \right. = .867 / .867 = 1 \quad CSCl_2$$

b. Draw the Lewis dot structure. (Note: Carbon is the central atom!)

Val e- $4+6+14 = 24$



c. This molecule has 3 sigma and 1 pi bonds.

d. What is the hybridization around the carbon? sp^2