General Chemistry I
Chem 111 Exam #4 - Vining

NAME: Answer key
December 11, 2015

1. ***4 pts***
What is the driving force causing the formation of a covalent bond between two atoms?
Choose one.

a. the ability to fill valence shells, usually with an octet of 8 electrons

b. the ability for electrons on one atom to be near the nucleus of another atom

c. the ability of electrons to "pair up" with other electrons from other atoms

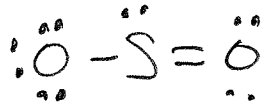
d. the ability of two nuclei to be closer to each other, increasing the strong nuclear force

2. ***3 pts*** How many valence electrons does each of the following have:

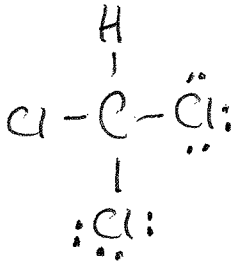
a) N 5 b) Mg 2 c) S^{2-} 8

3. ***12 pts***
Draw Lewis Dot structures for the following: If resonance forms exist, only draw one.

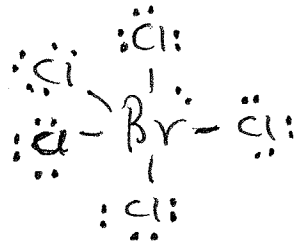
SO_2



$CHCl_3$ (all atoms bonded to C)



$BrCl_5$



4. ***4 pts***
For *each pair*, which bond is longer?

a. C-C or C-O — C is a larger atom than O

b. C-C or C≡C — multiple bonds are shorter

5. ***4 pts***
For *each pair*, which bond is stronger?

a. C-C or Si-Si — Smaller atoms make stronger bonds (usually)

b. C-C or C=C — multiple bonds are stronger

6. ***6 pts***
For *each pair*, which bond is more polar?

a. F-F or H-Cl — F-F is non-polar

b. C-O or Si-O — the larger Δ electronegativity, the more polar the bond

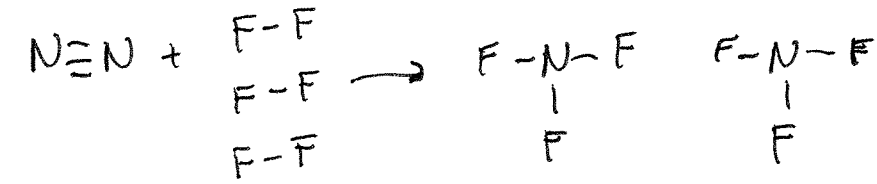
Why is a C-O bond polar?

7. ***6 pts***

What is ΔH for the following reaction? $N_2(g) + 3\,F_2(g) \longrightarrow 2\,NF_3(g)$

Bond energies:

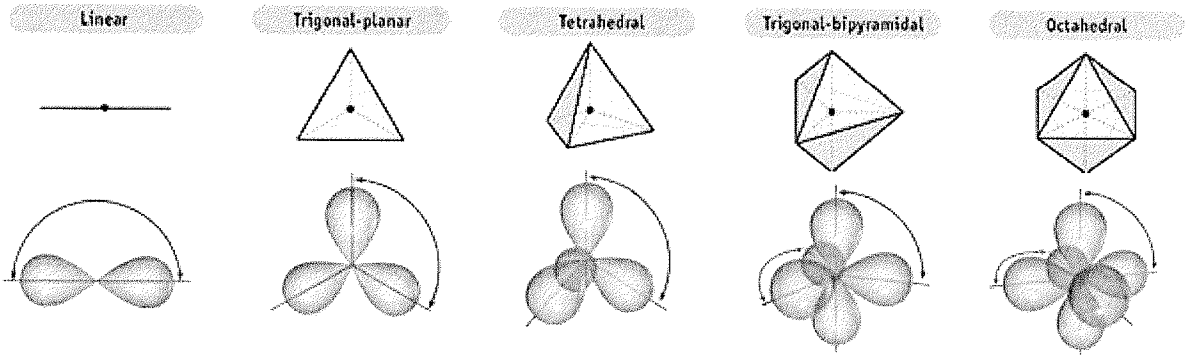
N≡N = 391 kJ/mol (should be 931)
F-F = 155 kJ/mol
N-F = 283 kJ/mol



bonds broken − bonds formed

391 + 3(155) − 6(283) = −302 kJ/mol
931

8. ***15 pts***



For each of the following molecules, give the Lewis structure, the electron-pair geometry, the molecular geometry, the bond angles, and determine the molecular polarity. Space is given to show your work.

HCN

H – C ≡ N:

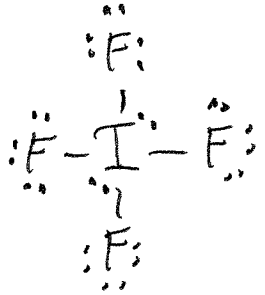
electron-pair geometry: linear

molecular geometry: linear

bond angles: 180°

polar or nonpolar?

IF_4^-



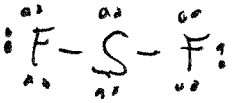
electron-pair geometry: octahedral

molecular geometry: square planar

bond angles: 90°

polar or nonpolar?

SF_2



electron-pair geometry: tetrahedral

molecular geometry: bent

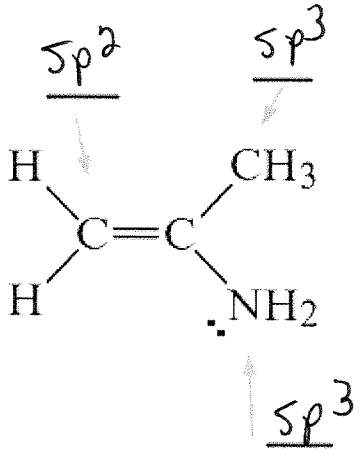
bond angles: 109.5° or a bit less

polar or nonpolar?

9. ***6 pts***
Draw all resonance structures for SO_2.

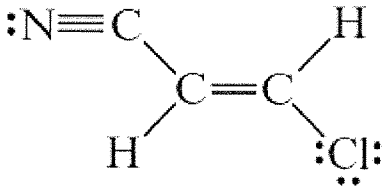
What is the average bond order for each sulfur-oxygen bond? 1.5

10. ***6 pts***
What hybrid orbitals are used by each indicated atom?



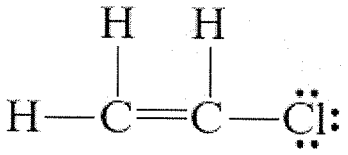
11. ***6 pts***
How many sigma and pi bonds are in the structure?

sigma: 6 pi: 3



12. ***6 pts***

Describe what orbitals are used to form each of the following bonds in CH_3CH_2Cl. Your answer should use language like "an sp^2 orbital on N overlaps with an sp^3 orbital on O".



First C-C bond: σ bond between sp^2 orbitals on each C atom

Second C-C bond: π bond between unhybridized 2p orbital on each C

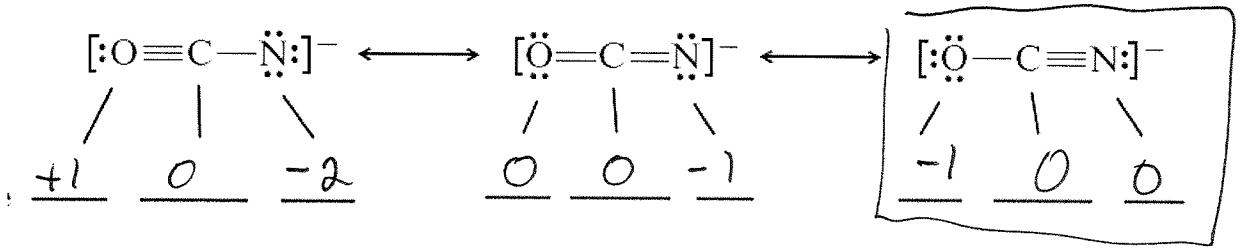
C-H bond: σ bond between sp^2 orbital on C and 1s orbital on H

13. ***8 pts***

Determine the formal charges on all atoms in these resonance structures of the OCN^- ion.

Draw a box around the most stable resonance structure.

Draw an arrow pointing to the least stable resonance structure.

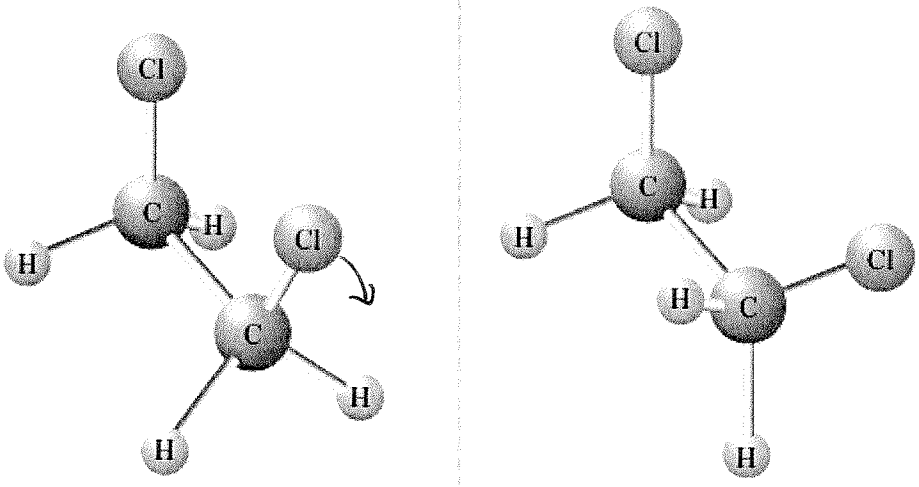


worst due to split charges

smallest formal charges and negative charge on most electronegative element

14. ***6 pts***

Are these two shapes: conformations or isomers



How do you know?

rotation happens about a single bond.

These two structures are a class of compounds called cycloalkanes.

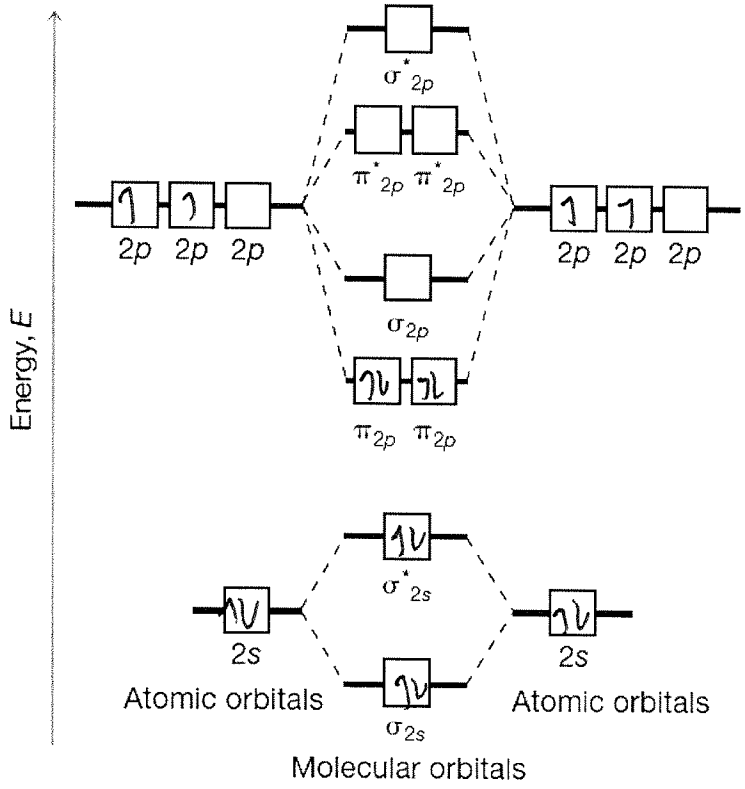
Are these two shapes: conformations or isomers

Explain why.

Although only single bonds are present the cyclic structure stops rotation from happening.

15. ***6 pts***

Fill electrons into the following MO diagram for the C_2 molecule. Notice that 1s orbitals are not included in this diagram.



8 valence electrons

What is the carbon-carbon bond order? 2

Is C_2: (diamagnetic) or paramagnetic

16. ***2 pts***

What is an antibond?

A molecular orbital that is higher in energy than the orbitals that it is made from. When electrons occupy an antibonding orbital, they cause the atoms to separate from each other.