

Exam 2

Name _____

Please read each question carefully, and make sure you provide all the requested information.

1. [17 pts]

a) [6 pts] Draw the MO diagram for the NF molecule (order the molecular orbitals as you would in F_2). Include the relative energies of the atomic orbitals, fill in the electrons and label the molecular orbitals.

b) [4pts] What is the bond order for this molecule?

Bond order = _____

c) [3pts] Is the molecule paramagnetic or diamagnetic?

circle one: paramagnetic diamagnetic

d) [4pts] Will NF^- have a longer or shorter bond? (please briefly explain)

circle one: longer shorter

Explanation:

2. [27 pts] Draw the Lewis structures for the following molecules. **Include (i) formal charges, (ii) oxidation states and (iii) all resonance structures.** The central atom is indicated in bold. For each structure, also indicate the steric number, hybridization, and the electronic geometry of the central atom.

a) [8 pts] **Br**O₃⁻

Br : Steric Number = _____ hybridization = _____ Geometry = _____

b) [8 pts] **P**F₆⁻

P : Steric Number = _____ hybridization = _____ Geometry = _____

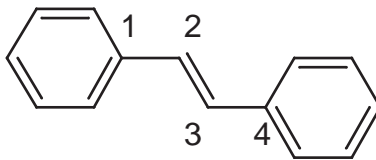
c) [8 pts] **S**OCl₂ (The arrangement of the atoms is non-linear)

S : Steric Number = _____ hybridization = _____ Geometry = _____

d) [3pts] For SOCl₂, how does the Cl – S – Cl bond angle deviate from ideal? (Please explain your answer)

3. [15 pts]

Consider the following molecule:



Stilbene

- a) [3pts] What is the molecular formula for this molecule?

Molecular formula = _____

- b) [2pts] How many pi orbitals are in this molecule? How many of these orbitals are filled?

number of pi molecular orbitals = _____

number of filled pi molecular orbitals = _____

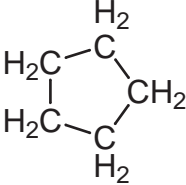
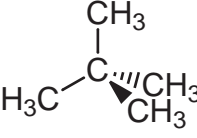
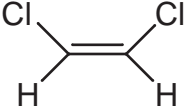
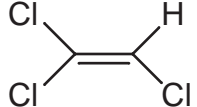
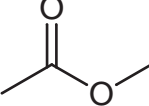
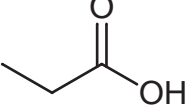
- c) [4pts] Sketch the lowest energy pi-orbital for this molecule. Sketch the highest-energy pi-orbital for this molecule. (The orbitals with intermediate energies are considerably more difficult to sketch.)

- d) [2pts] How does the rotational barrier about the C1 – C2 bond compare with that about the C2 – C3 bond?

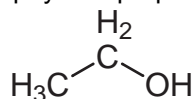
- e) [2pts] How does the rotational barrier about the C1 – C2 bond compare with the C – C bond of ethane (CH
- ₃
- CH
- ₃
-)?

- f) [2pts] Will the rotational barrier about the C2 – C3 bond increase or decrease when the molecule is excited?

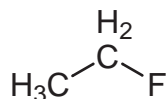
4. [21pts; 3pts each] Circle the best answer to the following questions.

Which molecule has the greater solubility in liquid CO ₂ ?	CH ₃ OH	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ OH
Which molecule has the greater solubility in liquid CO ₂ ?	CH ₃ CH ₂ F	CH ₃ CH ₂ Br
Which has the higher boiling point?		
Which has the stronger dispersion forces?	NH ₃	PH ₃
Which has greater attractive forces?		
Which has the higher polarizability?	CBr ₄	CF ₄
Which has the greater solubility in water?		

5. [8pts] Although ethanol, C₂H₆O, and fluoroethane, C₂H₅F, have very similar structures and dipole moments, they have some very different physical properties.



ethanol

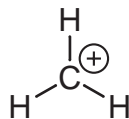


fluoroethane

a) [4pts] Which of these molecules will have the higher boiling point? Please explain your answer.

b) [4pts] Which of these molecules will be more soluble in liquid propane, CH₃CH₂CH₃? Please explain your answer.

6. [12 pts] Consider a methyl cation:



a) [4pts] Give the hybridization and the carbon atom, and the molecular geometry.

hybridization of C = _____ geometry = _____

b) [4pts] Which orbitals on the carbon form the bonds with the hydrogens? Sketch these orbitals.

c) [4pts] Are there any other orbitals on the carbon? If so, what are they and how many electrons do they hold? Sketch these orbitals.

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1) _____ /17

2) _____ /27

3) _____ /15

4) _____ /21

5) _____ / 8

6) _____ /12

total _____ /100