

Chapter 5: Advanced Theories of Bonding

H. Ryott Glayzer

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Notice of ADA Accommodation and Methods

I have an ADA accommodation to do my assignment on paper. This document is a utilization of that accommodation. This assignment will utilize questions from the textbook, *Chemistry: Atoms First, 2e*, to practice the skills and learning objectives for this class.

1 Valence Bond Theory

Q.1: Explain how σ and π bonds are similar and how they are different.

σ bonds are bonds that form in s-orbitals, while π bonds form in p-orbitals.

Q.5: A friend tells you that N_2 has three π bonds due to the overlap of the three p-orbitals in each Nitrogen atom. Do you agree?

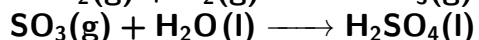
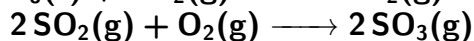
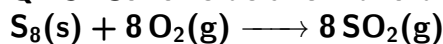
N_2 would have two π bonds and a σ bond.

2 Hybrid Atomic Orbitals

Q.9: Explain why a Carbon atom cannot form five bonds using sp^3d hybrid orbitals.

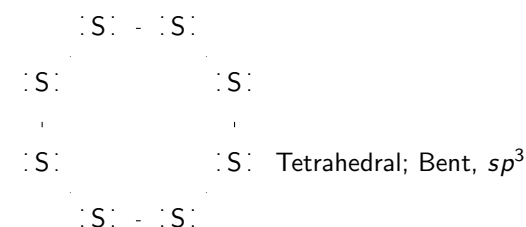
Carbon can only take four more valence shell electrons. sp^3 are what Carbon has since it can only form four bonds.

Q.13: Sulfuric acid is manufactured by the series of reactions:



Draw the Lewis Structure, predict the molecular geometry by VSEPR, and determine the hybridization of sulfur for the following:

a. Circular S_8 model

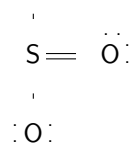


b. SO₂ molecule

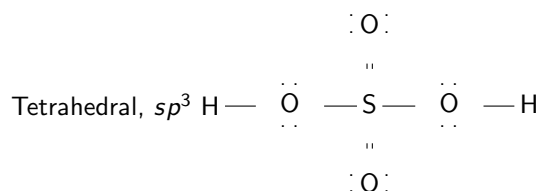
Bent, sp^2 $\ddot{\text{O}} \equiv \ddot{\text{S}} - \ddot{\text{O}}:$

c. SO₃ molecule

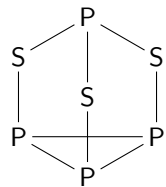
Trigonal Planar; sp^2 $\ddot{\text{O}}:$



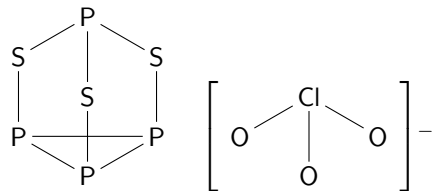
d. H₂SO₄ molecule



Q.17: Strike-anywhere matches contain a layer of KClO₃ and a layer of P₄S₃. The heat produced by the friction of striking the match causes these two compounds to react vigorously, which sets fire to the wooden stem of the match. KClO₃ contains the ClO₃⁻ ion. P₄S₃ is an unusual molecule with the following skeletal structure:



a. Write the Lewis structures for P₄S₃ and the ClO₃⁻ ion.



b. Describe the geometry about the P atoms, the S atom, and the Cl atom in these species

P: Trigonal Pyramidal; S: Bent, two lone pairs; Cl: Trigonal Pyramidal

c. Assign a hybridization to the P atoms, the S atom, and the Cl atom in these species

sp^3 for all

d. Determine the oxidation states and formal charge of the atoms in P_4S_3 and the ClO_3^- ion.

Atom	P	S	Cl	O
Oxidation States	+1	$-1\frac{1}{2}$	+5	-2
Formal Charge	0	0	+2	-1

3 Multiple Bonds

Q.21: The bond energy of a C-C single bond averages 347 kJ mol^{-1} ; that of a $\text{C}\equiv\text{C}$ triple bond averages 839 kJ mol^{-1} . Explain why the triple bond is not three times as strong as the single bond.

A triple bond is made of one σ bond and two π bonds. A σ bond is stronger than a π bond.

Q.25: Identify the hybridization of the central atom in each of the following molecules and ions that contain multiple bonds:

CINO	CS_2	Cl_2CO	Cl_2SO	SO_2F_2	XeO_2F_2	ClOF_2^+
sp^2	sp	sp^2	sp^3	sp^3	sp^3d	sp^3

Q.29: Draw the orbital diagram for carbon in CO_2 showing how many carbon atom electrons are in each orbital.



Orbitals in Carbon Hybridized Carbon in CO_2

These are: (sp: up), (sp: up), (2p: up), (2p: up), but I can't figure out the LaTeX for it

4 Molecular Orbital Theory

Q.33: Can a molecule with an odd number of electrons ever be diamagnetic? Explain why or why not.

No. An odd number of electrons will always be paramagnetic.

Q.37: Explain why an electron in the bonding molecular orbital in the H_2 molecule has a lower energy than an electron in the 1s atomic orbital hydrogen atoms.

The pairing of the two bonding electrons lowers the system's energy compared to a lone atom.

Grading

Points Possible	Points Earned	Score
32		/32