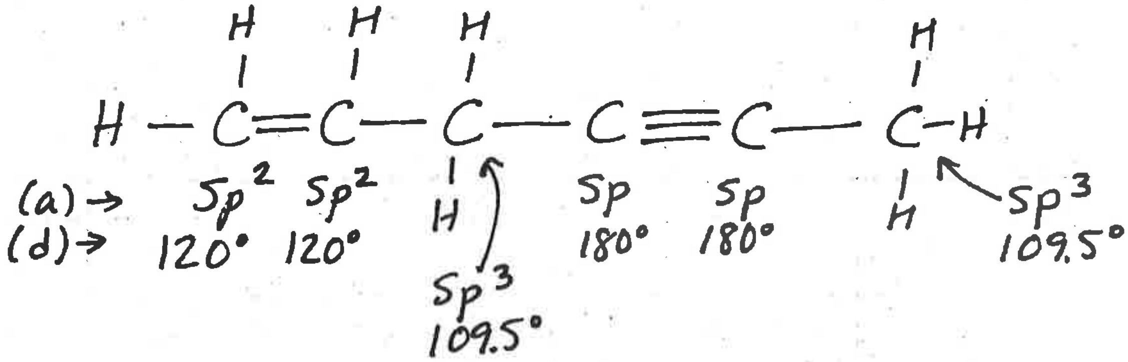
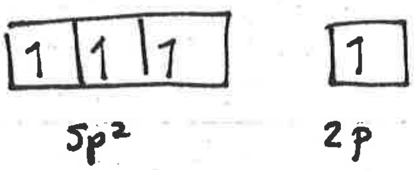
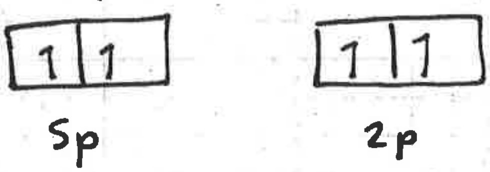
(8) Single bonds = sigma bonds (σ)
a Double bond = 1 sigma bond plus 1 pi bond ($1\sigma + 1\pi$)
a Triple bond = 1 sigma bond plus 2 pi bonds ($1\sigma + 2\pi$)



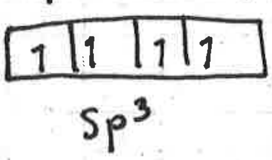
(e) each sp^2 carbon has one unhybridized p orbital, half filled (one electron)



each sp carbon has two unhybridized p orbitals, each half-filled (one e⁻ in each)



(In the sp^3 carbons, all 2p orbitals were involved in hybridization:)



(b) The molecule has 13 σ bonds
(c) and it has 3 σ bonds

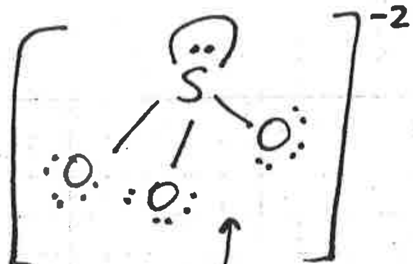
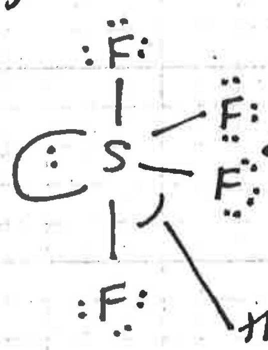
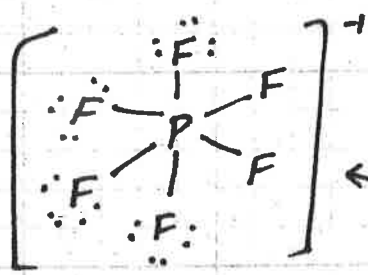
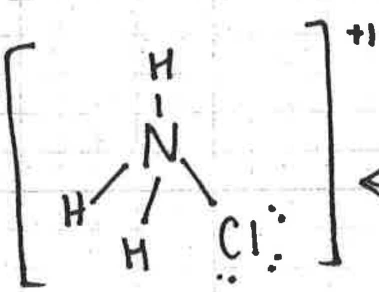
(f)
The half filled p orbitals are perpendicular to the sp or sp^2 hybrid orbitals. they are involved in making the pi bonds.

for a π bond to form between two carbons (or other elements) each carbon has a half filled p orbital that overlaps with the other atom's half filled p orbital, creating the π bond.

The triple bond has two π bonds in it, so each C involved in the triple bond needs two half filled p orbitals.

Chapter Nine

27

	Dot structure and bond ∡	Electron domain geometry	Molecular geometry
(a) HCN 10 v.e.	H—C≡N: 180°	linear	linear
(b) SO_3^{-2} 26 v.e.	 bond ∡ will be slightly less than 109.5°.. maybe about 107°	tetrahedral	trigonal pyramidal
(c) SF_4 34 v.e.	 thus ∡ will be slightly less than 120° this will be slightly less than 90°	trigonal bipyramidal	seesaw
(d) PF_6^{-1} 48 v.e.	 ← all bond ∡ are 90°	octahedral	octahedral
(e) NH_3Cl^{+1} 14 v.e.	 ← 109.5°	tetrahedral	tetrahedral
(f) N_3^{-1} 16 v.e.	$[:\ddot{N}=N=\ddot{N}:]^{-1}$ 180°	linear	linear

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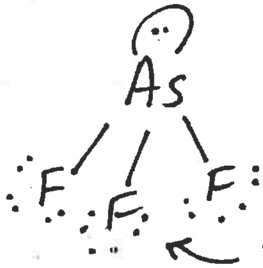
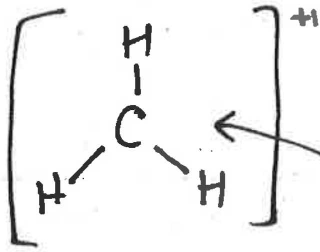
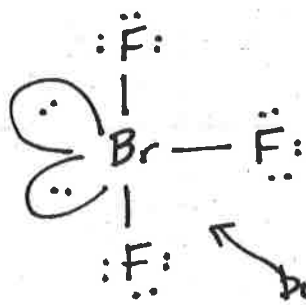
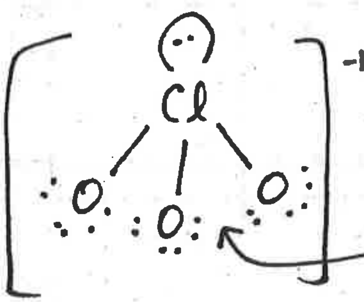
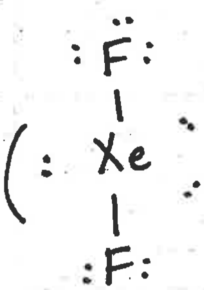
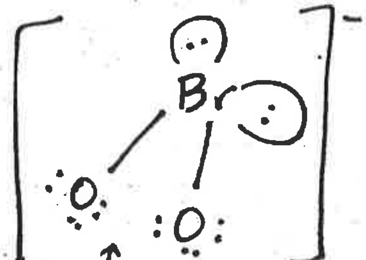
(28)

	Dot structure	electron domain geometry	molecular geometry
(a) AsF_3 26 v.e.		tetrahedral	trigonal pyramidal
(b) CH_3^{+1} 6 v.e.		trigonal planar	trigonal planar
(c) BrF_3 28 v.e.		trigonal bipyramidal	T-shaped
(d) ClO_3^{-1} 26 v.e.		tetrahedral	trigonal pyramidal
(e) XeF_2 22 v.e.		trigonal bipyramidal	linear
(f) BrO_2^{-1} 20 v.e.		tetrahedral	bent

(a) ← bond ∡ would be slightly less than 109.5°

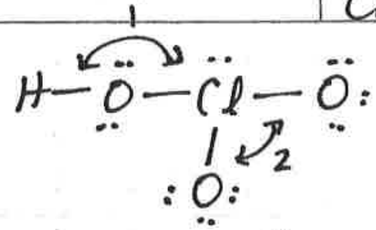
(b) ← 120°

(c) ← both bond angles are slightly less than 90°

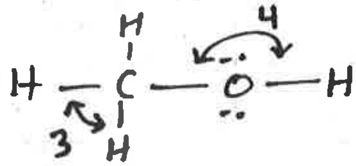
(d) ← slightly less than 109.5° maybe ≈ 107° ?

(e) 180°

(f) ↑ Bond ∡ is slightly less than 109.5°, maybe ≈105° ?

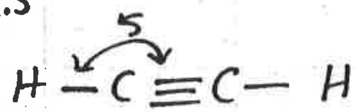
(31) (a) 

∡ #1 = 109.5° } actually slightly less, due to lp on Cl, O
∡ #2 = 109.5°

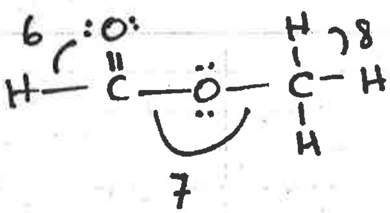
(b) 

∡ 4 = 109.5° (or a bit less)

∡3 = 109.5°

(c) 

∡ 5 = 180°

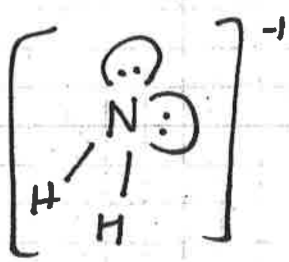
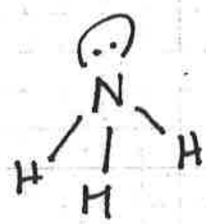
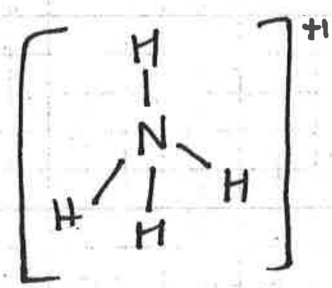
(d) 

∡ 6 = 120° or slightly more, due to double bond
∡ 7 = 109.5° or slightly less, due to lp
∡ 8 = 109.5

(34.) NH_2^{-1} vs NH_3 vs NH_4^{+1}

105° 107° 109° ← H–N–H bond angles

explain!

2 lone pairs 1 lone pair 0 lone pairs

Repulsions between lone pairs are the strongest, followed by repulsions between lone pairs and bond pairs, followed by repulsions between bond pairs and bond pairs.

NH_4^{+1} has the largest bond angle; since it has only bond pairs, are bond ∡s are the same. They are all 109.5°, as expected for tetrahedral geometry.

NH_3 has 1 lone pair, which repels the 3 bond pairs more strongly than they repel each other, so the bonds are pushed closer together, to a smaller (than 109.5°) angle of 107°.

NH_2^{-1} has 2 lone pairs, so the bond pairs are pushed even closer together, to a 105° bond angle.

(43) Polar or nonpolar?

To be polar, molecule must be asymmetrical, and the bonds must have a ΔEN of at least 0.5

(Looking up EN values on p. 299.)

(a) IF
EN= 2.5 4.0
ΔEN=1.5

δ+ :I–F: δ-

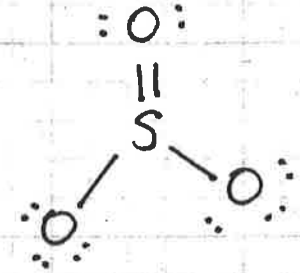
polar

(b) CS_2
2.5 2.5

nonpolar since ΔEN=0
(and even if it wasn't 0, it would be completely nonpolar due to symmetry, since it is linear.

:S=C=S:

(c) SO_3
2.5 3.5

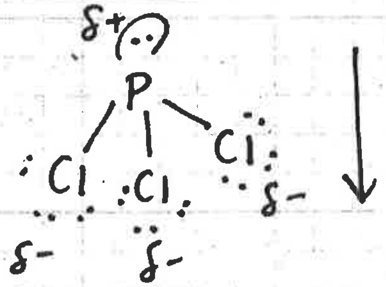


← actually has resonance over all 3 S–O bonds.

nonpolar

the bonds are polar, since ΔEN=1.0, but the polarity arrows add to zero; it is symmetrical

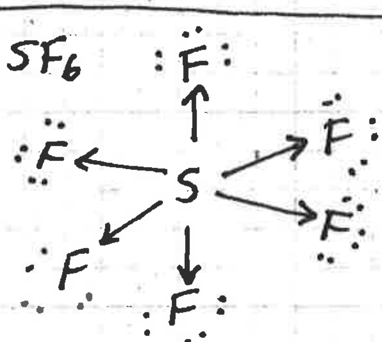
(d) PCl_3
2.1 3.0



net polarity arrow

polar

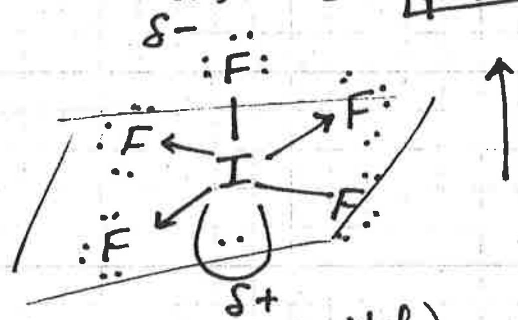
(e) SF_6



nonpolar due to symmetry

2.5 4.0 ΔEN=1.5

(f) IF_5 polar



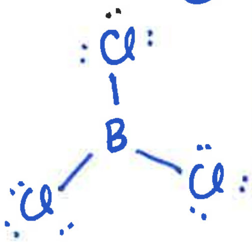
net polarity arrow

(square pyramidal)

(the 4 polarity arrows in the horizontal plane cancel out)

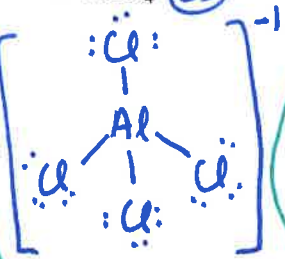
9.55. Indicate the hybridization of the central atom for each of these. (for HNO_2, do this for both "central atoms")
(Draw the dot structure of each to justify your answer)

a. BCl_3 (24)



3 domains
120° sp^2
(Boron doesnt get an octet)

b. $AlCl_4^{-1}$ (32)

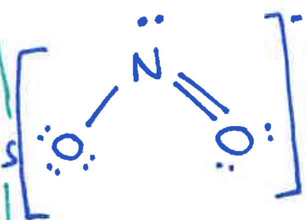


4 domains
109.5°
sp^3

c. CS_2 (16)

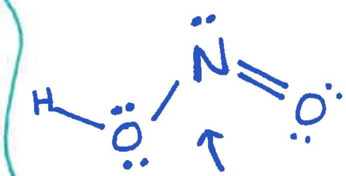
2 domains
180°
sp

d. NO_2^{-1} (18)



3 domains
120° (ideal)
sp^2

e. HNO_2 (18)

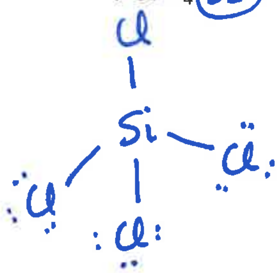


3 domains
120° (ideal)
sp^2

4 domains
109.5° (ideal)
sp^3

9.56. Indicate the hybridization of the central atom for each of these.
(Draw the dot structure of each to justify your answer)

a. $SiCl_4$ (32)

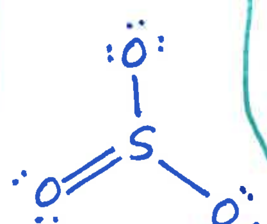


4 domains
109.5°
sp^3

b. HCN (10)

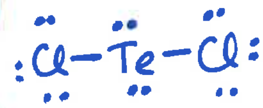
2 domains
180°
sp

c. SO_3 (24)



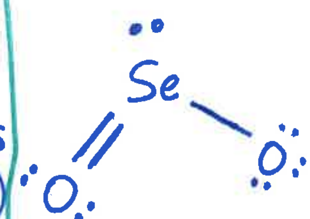
3 domains
120°
sp^2

d. $TeCl_2$ (20)



4 domains
109.5° (ideal)
sp^3

e. SeO_2 (18)



3 domains
120° (ideal)
sp^2

9.57. Of the molecules and ions in #55 and #56 (above), which of them would have resonance?
List the formulas of those that would have resonance: NO_2^{-1}, SO_3, SeO_2

Must have a double bond with more than 1 (equivalent) location to put the bond.

but not HNO_2
because if the double bond was with the other oxygen that O would have 3 bonds, and a positive formal charge, so the 2 oxygens arent equivalent.