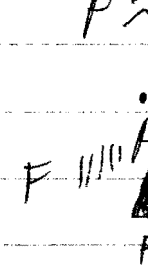
HW #3

60, 64, 66, 70, 88, 90, 92, 96, 100, 105

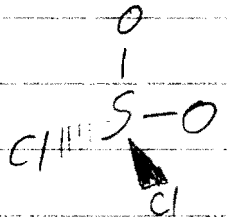
(60) A. PF_3 $P \cong N$ = valence SN = (Number of Atoms bound) + (Number of lone pairs on Atoms LP)



SN = 3 + 1 = 4

trigonal pyramidal

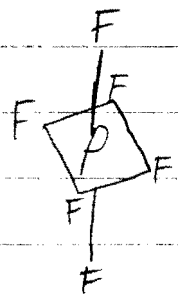
B. SO_2Cl_2



SN = 4 + 0 = 4

tetrahedral

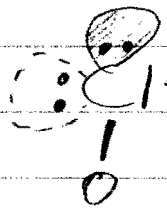
C. PF_6^-



Octahedral

SN = 6 + 0 = 6

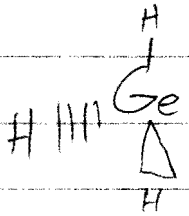
D. ClO_2^-



SN = 2 + 2 = 4

Bent

E. GeH_4



tetrahedral

SN = 4 + 0 = 4

(64) A. AB_4^- tetrahedral ClO_4^-

B. AB_2 - linear CO_2

C. AB_6^- octahedral SbF_6^-

D. AB_3^- Pyramidal ClO_3^-

(66) A. Polar From problem (60)
B. Polar
C. Nonpolar
D. Polar
E. Nonpolar

(70) A. 

From the description the molecule is either bent or non-symmetric linear.

B. Use VSEPR to determine structure
$SN = 3$ so the molecule is bent.

(88) A. $Na_{(g)} + I_{(g)} \xrightarrow{IE + (-EA)} Na^+_{(g)} + I^-_{(g)}$

$\Delta E = IE + (-EA)$

$(495.8\ KJ/mol) + (-295.2\ KJ/mol) = 200.6\ KJ/mol$

$Na_{(g)} + I_{(g)} \xrightarrow{EA \quad IE} Na^-_{(g)} + I^+_{(g)} =$

$(1008.4\ KJ/mol) + (-52.867\ KJ/mol) = 955.533\ KJ/mol$

(88)

B. $K_{(g)} + Cl_{(g)} \xrightarrow{IE,\ EA} K^+_{(g)} + Cl^-_{(g)}$

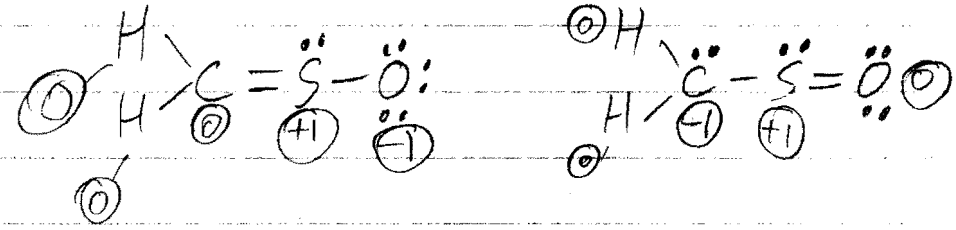
$(418.8\ KJ/Mol) + (-349.0\ KJ/Mol) = 69.8\ KJ/Mol$

$K_{(g)} + Cl_{(g)} \xrightarrow{EA,\ IE} K^-_{(g)} + Cl^+_{(g)}$

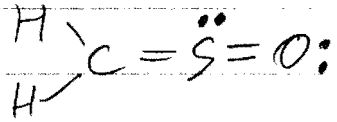
$(1251.1\ KJ/Mol) + (-48.384\ KJ/Mol) = 1202.716\ KJ/Mol$

The creation of $K^+_{(g)} + Cl^-_{(g)}$ is much more energetically favorable than the creation of $K^-_{(g)} + Cl^+_{(g)}$. same goes for $Na^+_{(g)} + I^-_{(g)}$ with respect to $Na^-_{(g)} + I^+_{(g)}$.

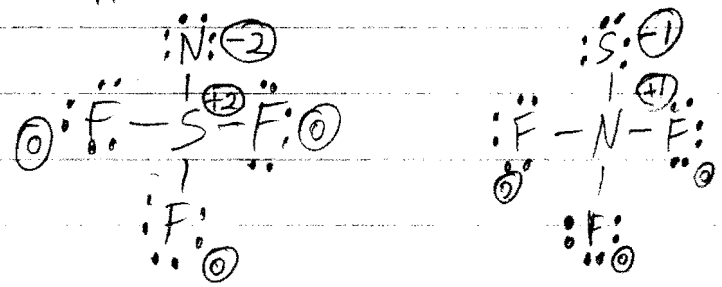
(90) A. formal charges



B. all formal charges = 0 (octet violated)

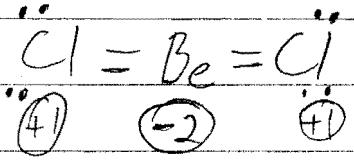


(92) A. SF_3N

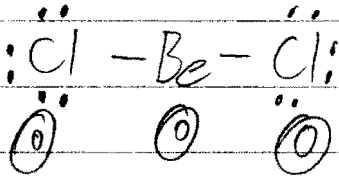


B. Central nitrogen is preferred due to lower formal charge.

(96) A. $BeCl_2$ 16



B. $BeCl_2$



(100) KCl $\mu = 10.3\ D$ Bond distance = 2.67 Å

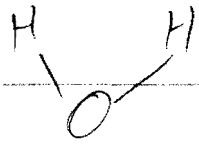
Dipole moment of KCl if opposite charges of $1.6 \times 10^{-19} C$ at nuclei?

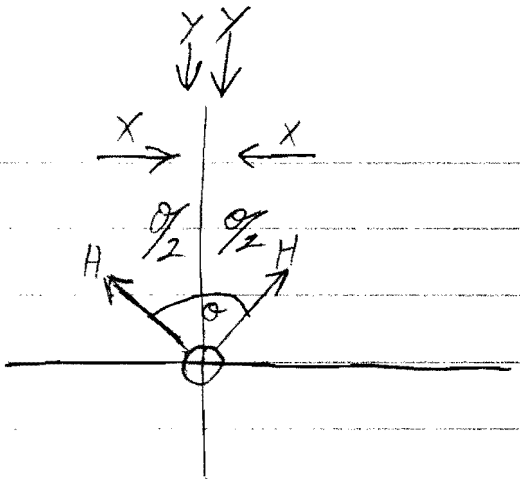
$$1D = 3.336 \times 10^{-30} C\,M$$

$$\mu = \frac{2.67 \times 10^{-10}\,\cancel{M} \cdot 1.6 \times 10^{-19} C}{3.336 \times 10^{-30} C\,\cancel{M}/D} = \boxed{12.82\ D}$$

$$\frac{10.3\ D}{12.82\ D} = 80.3\%$$

(105) H_2O





$\mu(H_2O) = 2\mu_{OH}\cos(\theta/2)$

The X components of the dipole are equal and opposite, so they cancel. The y components can be added together

If $\mu(H_2O) = 1.86\,D$ then $\theta = 104.5°$

page 94
Fig 3.19 (B)

$1.86 = 2\mu_{(OH)}\cos\left(\frac{104.5}{2}\right)$

$\frac{1.86\,D}{2\cos\left(\frac{104.5}{2}\right)} = \mu(OH) = 1.52\,D$

Other Problems

(1) CH_3Cl vs CH_3I

Larger H-C-X bond angle = CH_3I

I is much larger than Cl so it requires more room, pushing the H atoms farther away.

The high electronegativity of Cl pulls electron density away from the central atom. This reduces the electron pair repulsion allowing the hydrogens to spread out more. (Page 95)

Larger dipole = CH_3Cl

Cl is more electronegative than I.

(2) Largest dipole moment

N_2

$:N \equiv N:$

No net dipole (Same EA)

CO_2

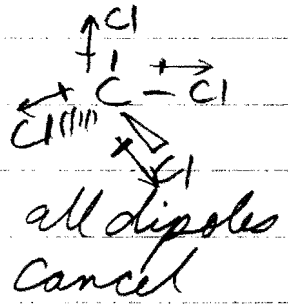
$:\ddot{O}=C=\ddot{O}:$

No net dipole

HCl

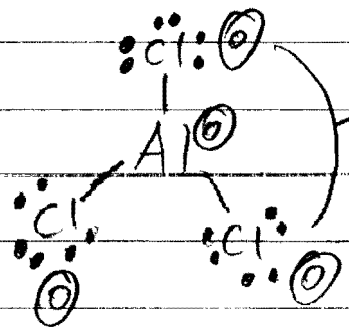
Net dipole

Winner



all dipoles cancel

(3) Lewis Dot for $AlCl_3$



electrons
Al = 3
3 Cl = 21
24
−24
0

trigonal planar

Circle = $\frac{360^\circ}{3} = 120^\circ$

Non-Polar