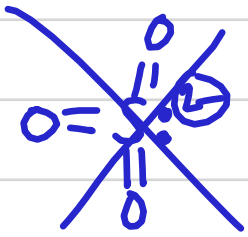
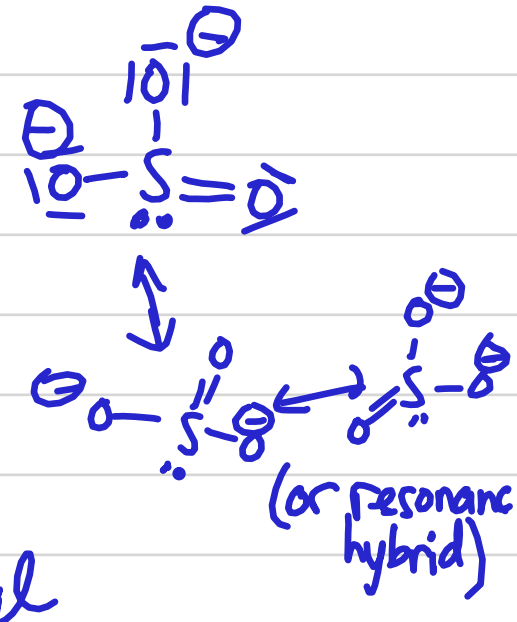
Chem151B, Spring 2018
Problem Set #1

1. (a) SO_3^{2-}
$6+18+2=26e^-$

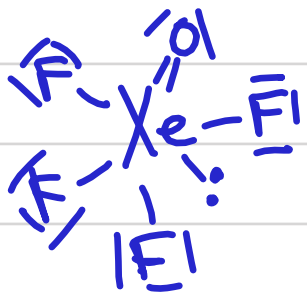




(trigonal) pyramidal

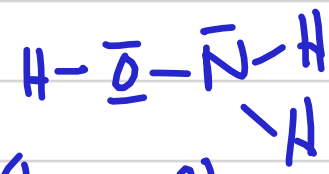
(or resonance hybrid)

(b) $XeOF_4$
$8+6+28=42e^-$



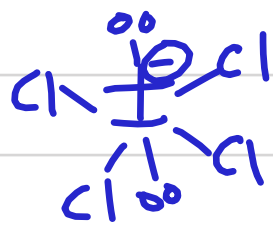
square pyramidal

(c) $HONH_2$
$H6+5+2=14e^-$



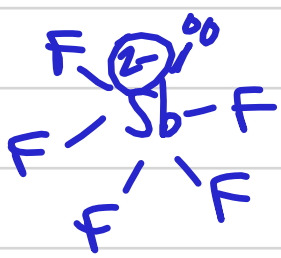
(trigonal) pyramidal

(d) ICl_4^-
$7+28+1=36e^-$



sq. planar

(e) SbF_5^{2-}
$5+35+2=42e^-$



sq. pyramidal

2. (a) B_5H_{11}

B–H units: $5\times2=10e^-$

6 extra Hs: $6\times1=6e^-$

$16e^-$

8 e^- skeletal e^- pairs, $n=5 \Rightarrow n+3$,
arachno, based on $5+2=7$ vertex polyhedron,
missing two vertices
PBP missing two vertices (one axial, one equatorial)
(enough for answer) ("pentagonal" also OK)

(b) $C_4B_2H_6$

C–H units: $4\times3=12e^-$

B–H units: $2\times2=4e^-$

$16e^-$

8 skeletal e^- pairs, $n=6 \Rightarrow n+2$,
nido, based on $(n+1)=7$-vertex polyhedron
PBP missing one vertex or pentagonal pyramidal

(c) $C_2B_3H_5Fe(CO)_3$

C–H units: $2\times3=6e^-$ $14e^-$, 7 pairs,

B–H units: $3\times2=6e^-$ $n=6 \Rightarrow n+1$ pairs

CO's: $3\times2=6e^-$ $\Rightarrow$ closo,

Fe: $8e^-$ octahedral

Factor out $12e^-$

for each M: $-12e^-$

(d) $Fe_4(CO)_{13}C$

Fe: $8 \times 4 = 32e^-$

CO's: $13 \times 2 = 26e^-$

C: $1 \times 4 = 4e^-$

Factor out $12 \times 4 = 48e^-$

$14e^-$

7 pairs, n=4 (C in center)

⇒ n+3, arachno, based on 6-vertex polyhedron, octahedral, missing two vertices, see-saw/disphenoidal (sq. pl. ok)

(e) $Fe_2Rh_2(CO)_{12}$

Fe: $8 \times 2 = 16e^-$

Rh: $9 \times 2 = 18e^-$

CO's: $12 \times 2 = 24e^-$

Factor out $12 \times 4 = 48e^-$

$10e^-$

5 pairs, n=4

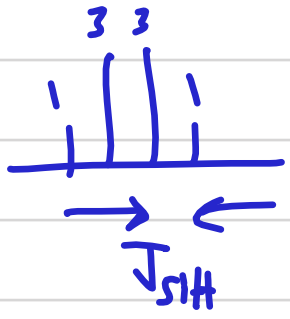
⇒ n+1 pairs, closo, tetrahedral

3. $SiH_3Cl_{(g)}$ ⇒ isotropic

^{29}Si, I=½, N=4.7%

^1H, I=½, N=99.9%

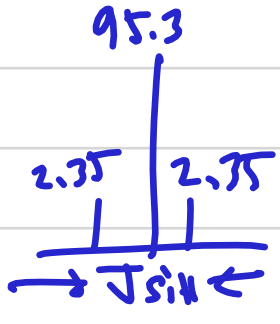
^{29}Si:



^1H: C_{3v}, all Hs equivalent

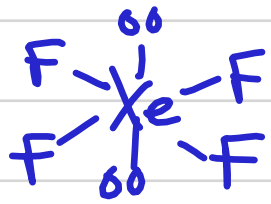
95.3% bonded to ^{28}Si, no splitting

4.7% bonded to ^{29}Si, $2nI+1 = 2(1)(½)+1 = 2$, doublet



4. XeF_4

$8+28=36e^-$



sq. planar

^{129}Xe, $I=\frac{1}{2}$, $N=26\%$

^{19}F, $I=\frac{1}{2}$, $N=100\%$

^{129}Xe NMR:

couples to 4 equivalent F_s

$2nI+1=2(4)(\frac{1}{2})+1$

$=5$

1:4:6:4:1 quintet

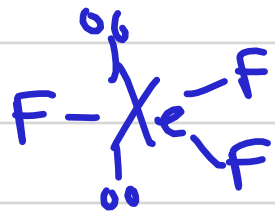
SbF_5 extracts F^-

$\rightarrow SbF_6^-$,

leaving XeF_3^+

XeF_3^+

$8+21-1=28e^-$



T-shaped

Axials split, $2nI+1=2(2)(\frac{1}{2})+1$

$=3$,

1:2:1 triplet

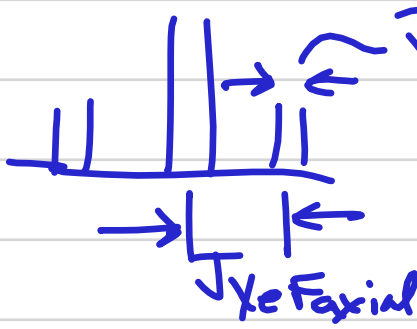
Eq split, $2nI+1=2(1)(\frac{1}{2})+1$

$=2$,

1:1 doublet

1:2:1

triplet of 1:1 doublets



$J_{Xe\text{-}Feq} > J_{Xe\text{-}Fax}$

∴ question said triplet, then each component split further into doublet

(i.e. not a doublet of triplets)