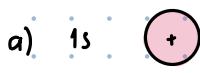


1.



$$n=1 \quad l=0 \quad m_l=0$$

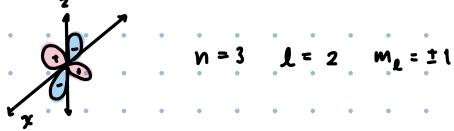
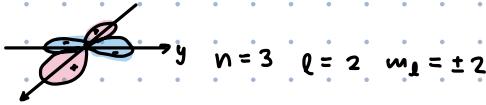


$$n=2 \quad l=1 \quad m_l=0$$

c) does NOT exist



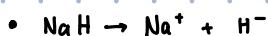
$$n=3 \quad l=2 \quad m_l=0$$



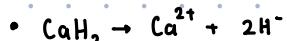
2.



Core	Valence	Term Symbol		
$\text{Na}^+$ : $\text{Na}^{11+}, \text{K}^2\text{L}^8   ^+$	$3s^0 p^0   ^+$	$s=0$	$l=0$	$j=0$
$\text{Cl}^-$ : $\text{Cl}^{17+}, \text{K}^2\text{L}^8   ^{7+}$	$3s^2 p^6   ^-$	$s=0$	$l=0$	$j=0$



$\text{Na}^+$ : $\text{Na}^{11+}, \text{K}^2\text{L}^8   ^+$	$3s^0 p^0   ^+$	$s=0$	$l=0$	$j=0$	${}^1S_0$
$\text{H}^-$ : $\text{H}^+, -$	$1s^2   ^-$	$s=0$	$l=0$	$j=0$	${}^1S_0$



$\text{Ca}^{2+}$ : $\text{Ca}^{20+}, \text{K}^2\text{L}^8 \text{M}^8   ^{2+}$	$4s^0 p^0   ^{2+}$	$s=0$	$l=0$	$j=0$	${}^1S_0$
$\text{H}^-$ : $\text{H}^+, -$	$1s^2   ^-$	$s=0$	$l=0$	$j=0$	${}^1S_0$



$\text{La}^{3+}$ : $\text{La}^{57+}, \text{K}^2\text{L}^8 \text{M}^8 \text{N}^{18} \text{O}^8   ^{3+}$	$5f^0 d^0   ^{3+}$	$s=0$	$l=0$	$j=0$	${}^1S_0$
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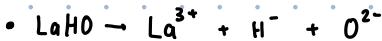
$\text{Be}^{2+}$ : $\text{Be}^{4+}, \text{K}^2   ^{2+}$	$2s^0 p^0   ^{2+}$	$s=0$	$l=0$	$j=0$	${}^1S_0$
$\text{C}^{4+}$ : $\text{C}^{6+}, \text{K}^2   ^{4+}$	$2s^0 p^0   ^{4+}$	$s=0$	$l=0$	$j=0$	${}^1S_0$



$\text{O}^{2-}$ : $\text{O}^{8+}, \text{K}^2   ^{6+}$	$2s^2 p^6   ^{2-}$	$s=0$	$l=0$	$j=0$	${}^1S_0$
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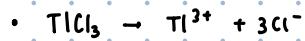
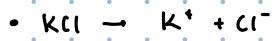
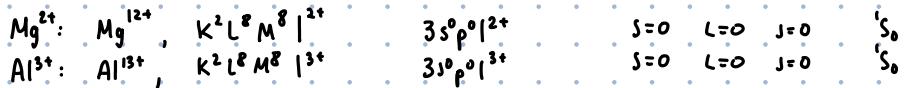
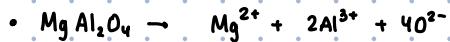
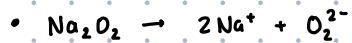
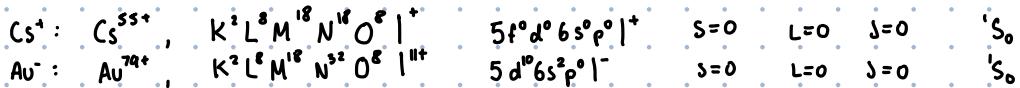


$\text{N}^{3-}$ : $\text{N}^{7+}, \text{K}^2   ^{5+}$	$2s^2 p^6   ^{3-}$	$s=0$	$l=0$	$j=0$	${}^1S_0$
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$\text{La}^{3+}$ : $\text{La}^{57+}, \text{K}^2\text{L}^8 \text{M}^8 \text{N}^{18} \text{O}^8   ^{3+}$	$5f^0 d^0 6s^0 p^0   ^{3+}$	$s=0$	$l=0$	$j=0$	${}^1S_0$
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3.

$$\text{V}^{3+} : 3d^2 \quad \begin{array}{|c|c|c|c|c|}\hline & 2 & 1 & 0 & -1 & -2 \\ \hline 1 & 1 & & & & \\ \hline \end{array} \quad s=1 \quad L=2+1=3 \quad J=3-1=2 \quad {}^3F_2$$

$$\text{Ca}^{2+} : 3s^2 p^6 \quad s=0 \quad L=0 \quad J=0 \quad {}^1S_0$$

$$\text{Sc}^{3+} : 3s^2 p^6 \quad s=0 \quad L=0 \quad J=0 \quad {}^1S_0$$

$$\text{Ti}^{3+} : 3d^1 \quad s=1/2 \quad L=2 \quad J=3/2 \quad {}^2D_{3/2}$$

$$\text{Mn}^{2+} : 3d^5 \quad s=5/2 \quad L=2+1-1-2=0 \quad J=5/2 \quad {}^6S_{5/2}$$

$$\text{Fe}^{2+} : 3d^6 \quad s=2 \quad L=2(2)+1-1-2=2 \quad J=4 \quad {}^5D_4$$

$$\text{Fe}^{3+} : 3d^5 \quad s=5/2 \quad L=2+1-1-2=0 \quad J=5/2 \quad {}^6S_{5/2}$$

$$\text{Co}^{2+} : 3d^7 \quad s=3/2 \quad L=2(2)+2(1)-1-2=3 \quad J=9/2 \quad {}^4F_{9/2}$$

$$\text{Ni}^{2+} : 3d^8 \quad s=1 \quad L=2(2)+2(1)+2(0)-1-2=3 \quad J=4 \quad {}^3F_4$$

$$\text{Ni}^{3+} : 3d^7 \quad s=3/2 \quad L=2(2)+2(1)-1-2=3 \quad J=9/2 \quad {}^4F_{9/2}$$

$$\text{Cu}^{2+} : 3d^9 \quad s=1/2 \quad L=2(2)+2(1)+2(0)-2(1)-2=2 \quad J=5/2 \quad {}^2D_{5/2}$$

$$\text{Cu}^+ : 3d^{10} \quad s=0 \quad L=0 \quad J=0 \quad {}^1S_0$$

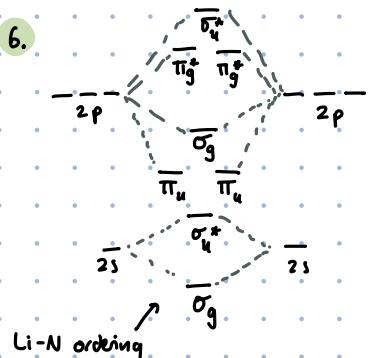
4.

$$\text{Ti}^+ : 6s^2 \quad \begin{array}{|c|c|c|}\hline & 1 & 1 \\ \hline n & s & s \\ \hline l & 0 & 0 \\ \hline m_l & 0 & 0 \\ \hline m_s & 1/2 & -1/2 \\ \hline \end{array}$$

$$\text{O}^{2-} : 2s^2 p^6 \quad \begin{array}{|c|c|c|}\hline & 1 & 1 \\ \hline n & 2 & 2 \\ \hline l & 0 & 0 \\ \hline m_l & 0 & 0 \\ \hline m_s & 1/2 & -1/2 \\ \hline \end{array} \quad \begin{array}{|c|c|c|}\hline & 1 & 1 \\ \hline n & 2 & 2 \\ \hline l & 1 & 1 \\ \hline m_l & 0 & 0 \\ \hline m_s & 1/2 & -1/2 \\ \hline \end{array}$$

$$\text{Fe}^{3+} : 3d^5 \quad \begin{array}{|c|c|c|c|c|c|}\hline & 1 & 1 & 1 & 1 & 1 \\ \hline n & 3 & 3 & 3 & 3 & 3 \\ \hline l & 2 & 2 & 2 & 2 & 2 \\ \hline m_l & 2 & 1 & 0 & -1 & -2 \\ \hline m_s & 1/2 & 1/2 & 1/2 & 1/2 & 1/2 \\ \hline \end{array}$$

5. a) Li<sup>+</sup> smaller k more electroneg than Na<sup>+</sup>  
 b) F<sup>7+</sup> " " " " Li<sup>+</sup>  
 c) O<sup>6+</sup> " " " " C<sup>4+</sup>  
 d) O<sup>6+</sup> " " (1) " " S<sup>6+</sup>



$$\bullet \text{Li}_2 \quad \sigma_g^2 \quad \text{B.O.} = \frac{2-0}{2} = 1 \quad \text{diamagnetic}$$

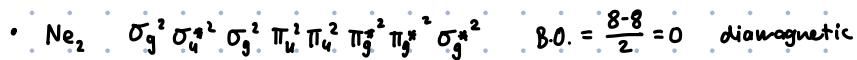
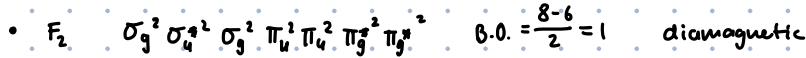
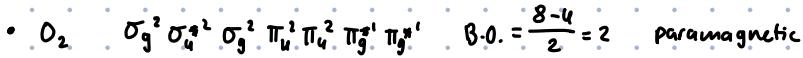


$$\bullet \text{Be}_2 \quad \sigma_g^2 \sigma_u^{\#2} \quad \text{B.O.} = \frac{2-2}{2} = 0 \quad \text{diamagnetic}$$

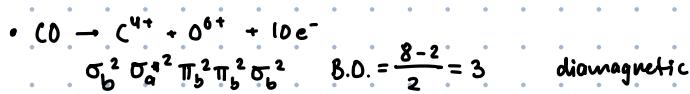
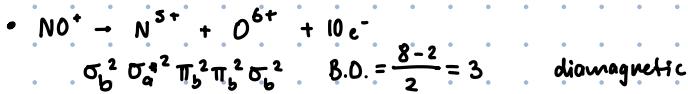


$$\bullet \text{B}_2 \quad \sigma_g^2 \sigma_u^{\#2} \pi_u^1 \pi_u^1 \quad \text{B.O.} = \frac{4-2}{2} = 1 \quad \text{paramagnetic}$$





↑ from comb. of 3s orbitals



Comparison of bond lengths & dissociation E:

a) bond length:

$$O_2^+ < O_2 < O_2^- < O_2^{2-}$$

diss. E:

$$O_2^+ > O_2 > O_2^- > O_2^{2-}$$

b) bond length:

$$NO^+ < NO < NO^-$$

diss. E:

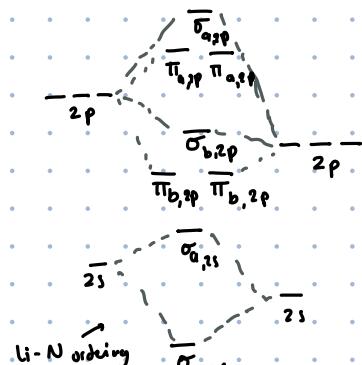
$$NO^+ > NO > NO^-$$

c) bond length:

$$H_2 < H_2^+ < H_2^- \quad H_2 \quad B.O. = \frac{1-0}{2} = \frac{1}{2}$$

diss. E:

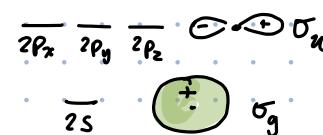
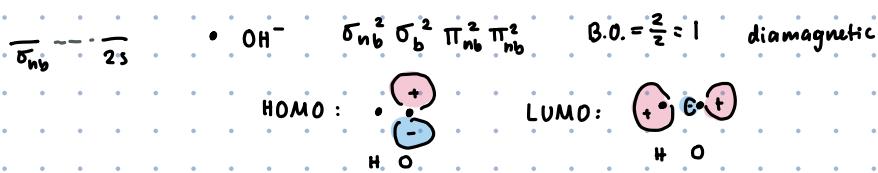
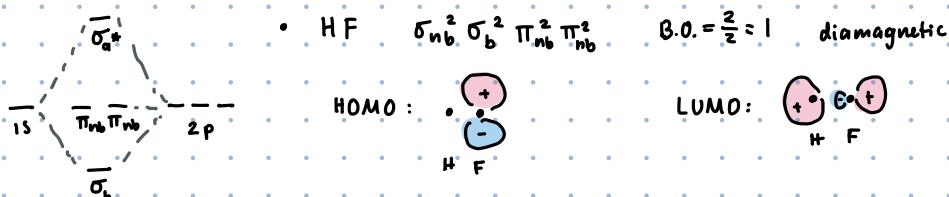
$$H_2^- > H_2^+ > H_2^- \quad H_2^- \quad B.O. = \frac{2-1}{2} = \frac{1}{2}$$



- $$\bullet \quad O_2^- \quad \sigma_g^2 \sigma_u^{+2} \sigma_g^2 \pi_u^2 \pi_u^2 \pi_g^2 \pi_g^{+2} \quad B.O. = \frac{8-s}{2} = \frac{5}{2} = 1.5 \quad \text{paramagnetic}$$

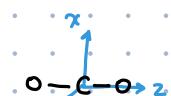
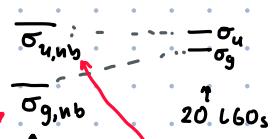
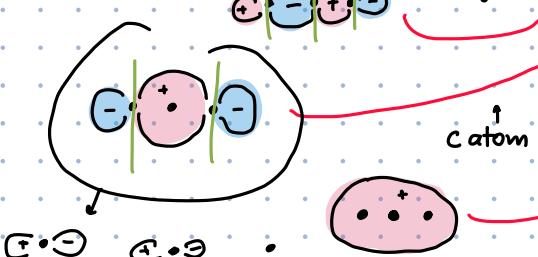
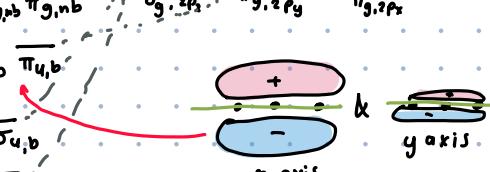
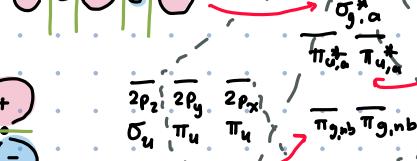
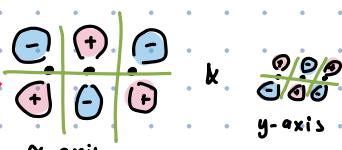
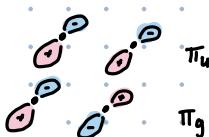
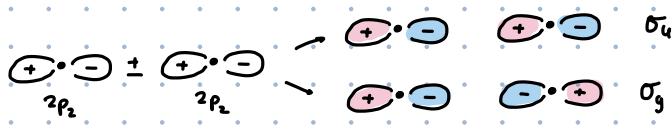
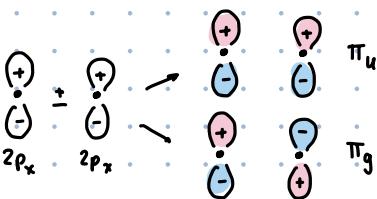
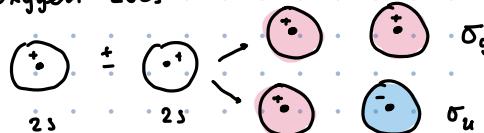


- $$\bullet \text{ } O_2^{2-} \quad \sigma_g^2 \sigma_u^{*2} \sigma_g^2 \pi_u^2 \pi_u^2 \pi_g^2 \pi_g^{*2} \text{ } B.O. = \frac{8-6}{2} = 1 \quad \text{diamagnetic}$$

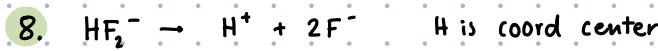


7.  $\text{CO}_2 \rightarrow \text{C}$  coord center

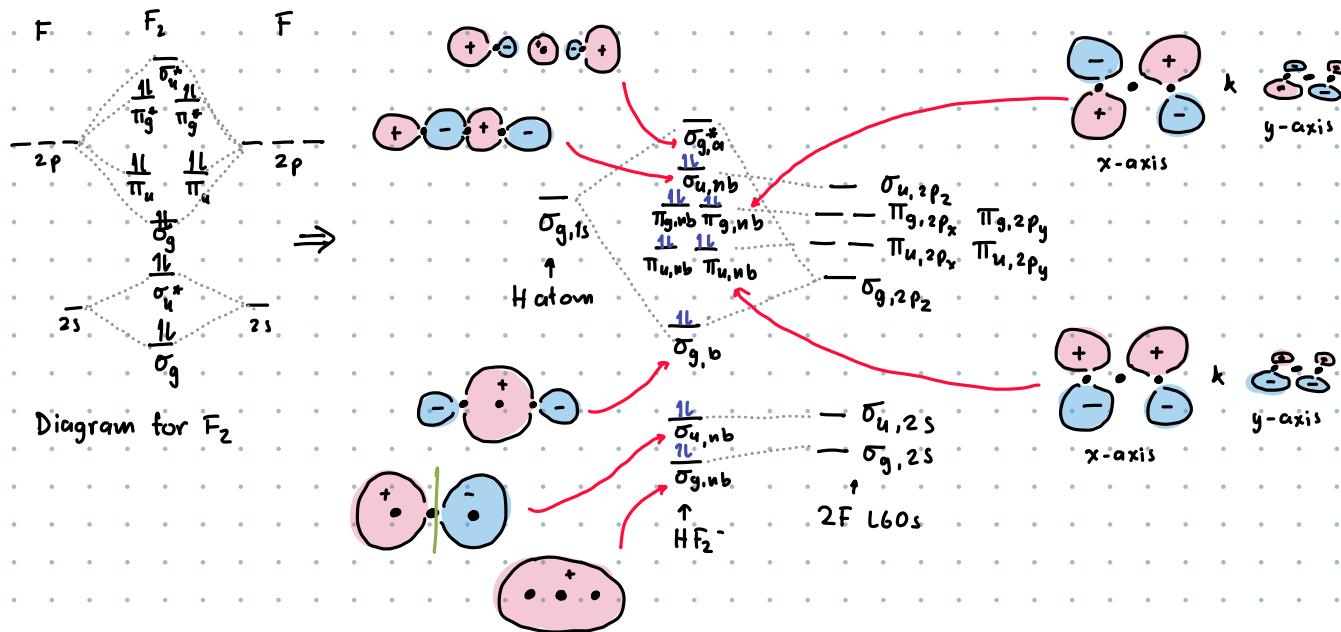
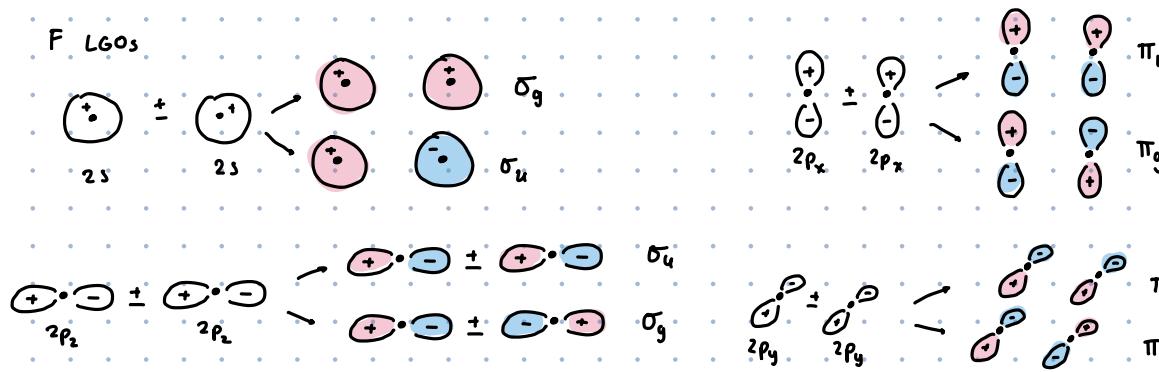
## Oxygen LGOs



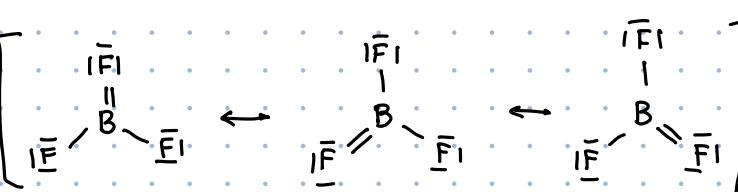
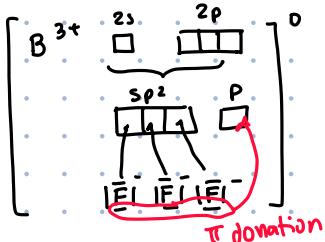
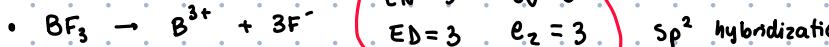
- Nodal planes
  - atomic nuclei



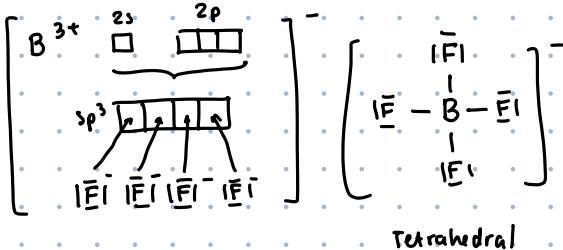
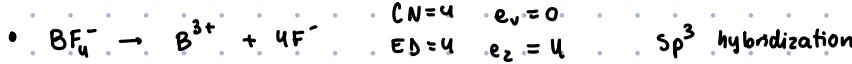
F LGOS

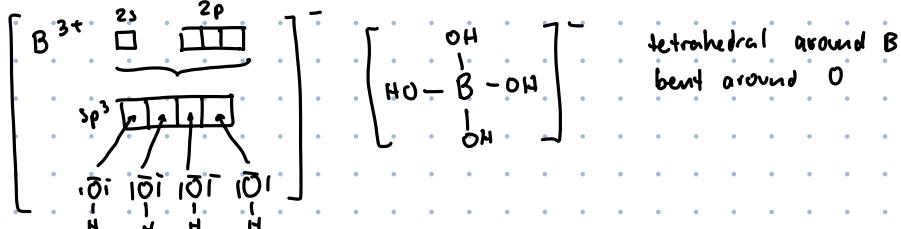
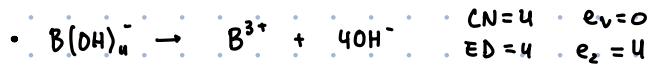
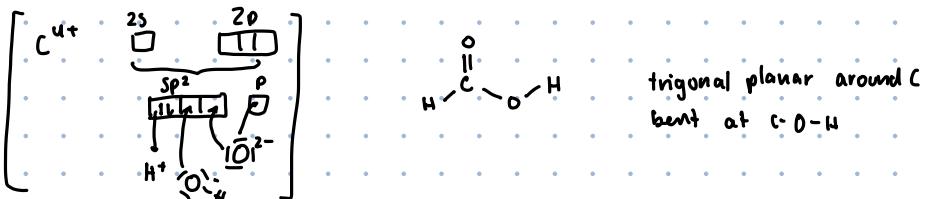
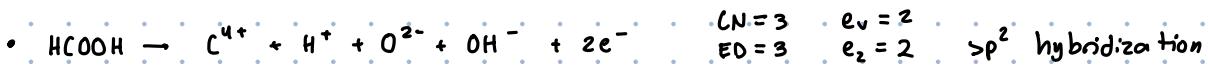
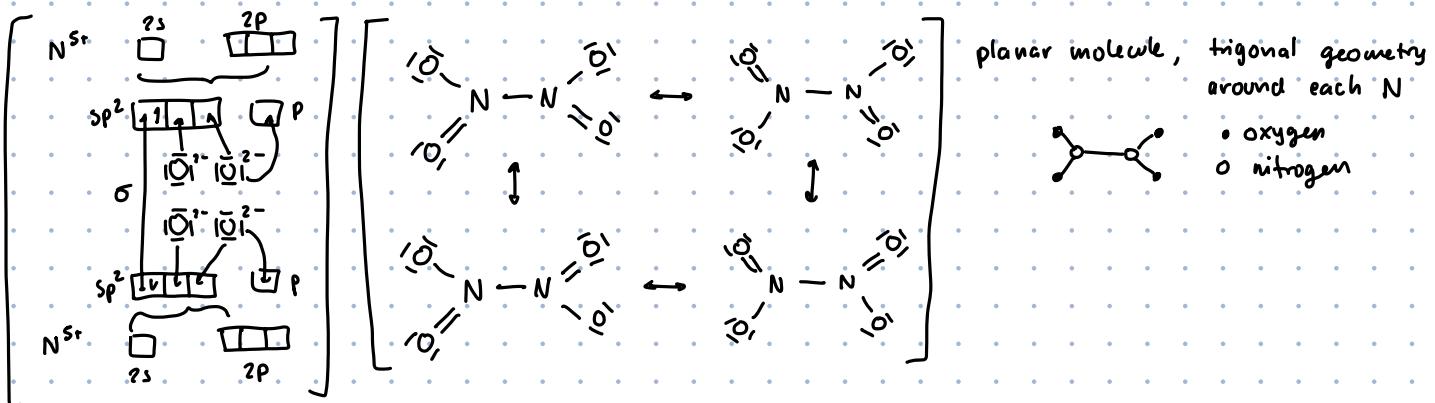
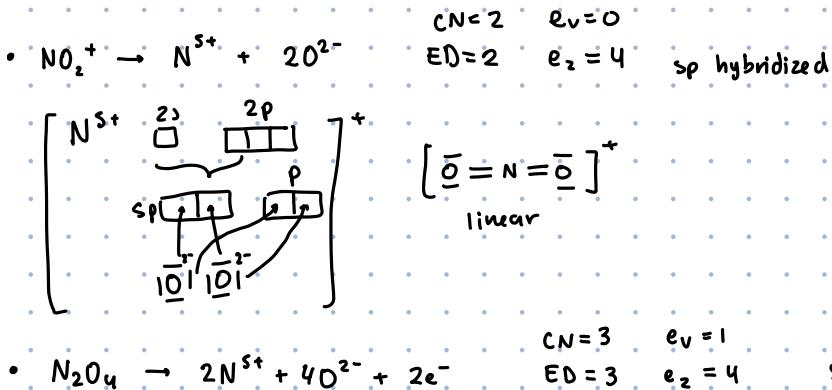
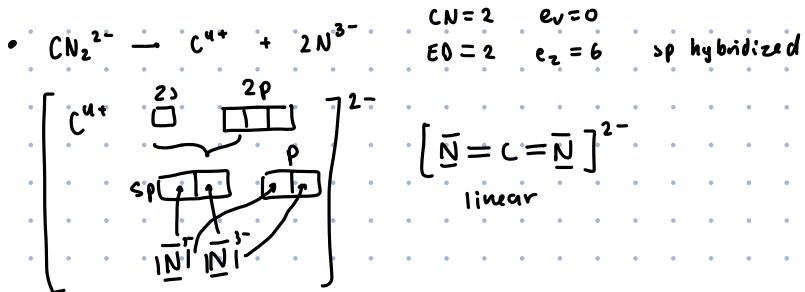


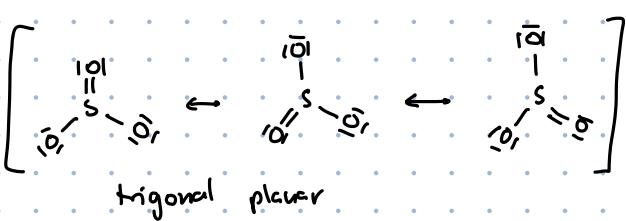
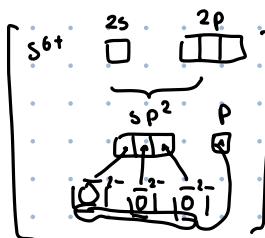
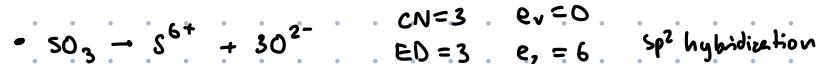
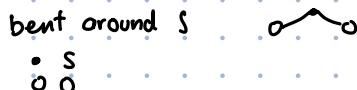
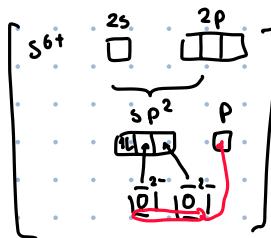
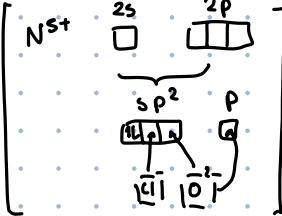
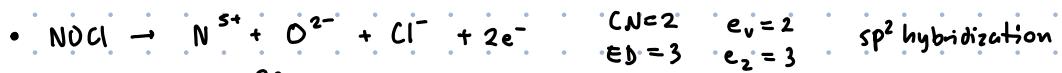
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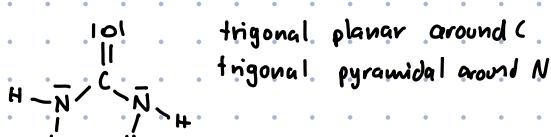
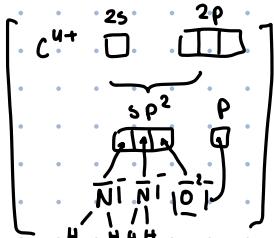
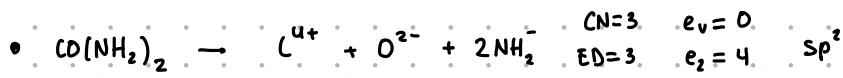
Trigonal  
planar



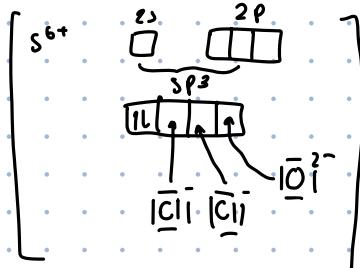
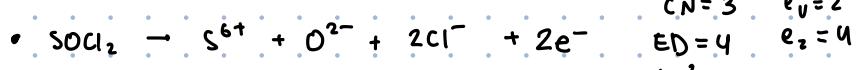




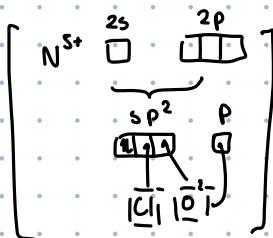
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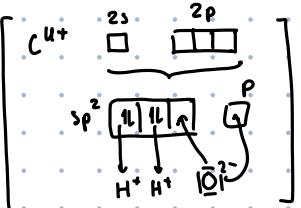
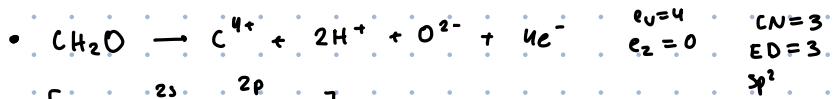
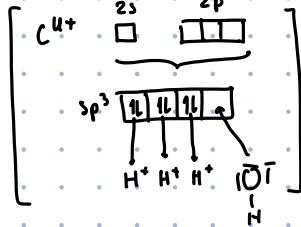
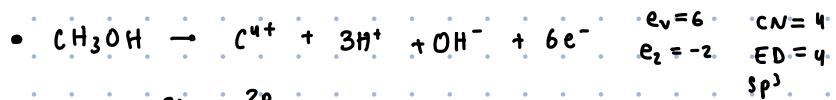
trigonal planar around C  
trigonal pyramidal around N



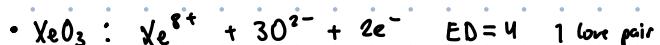
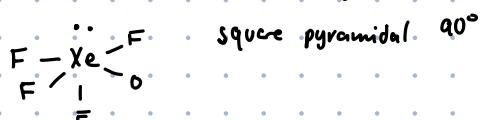
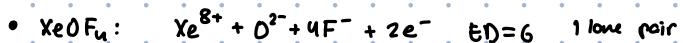
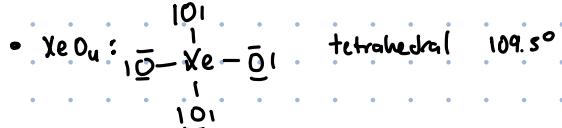
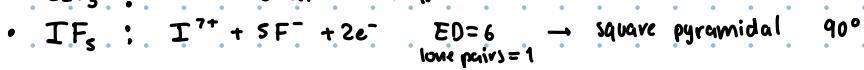
trigonal pyramidal

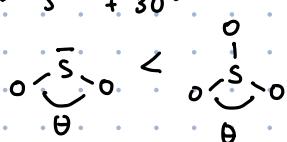
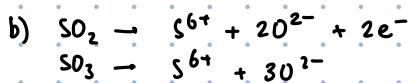
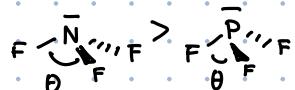
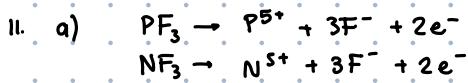
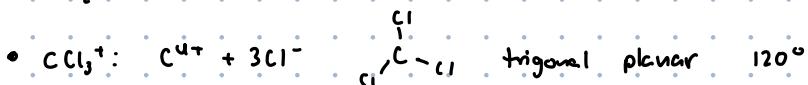
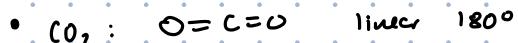
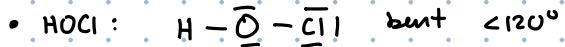
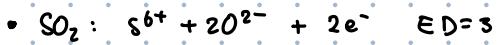
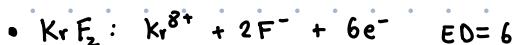


bent around N



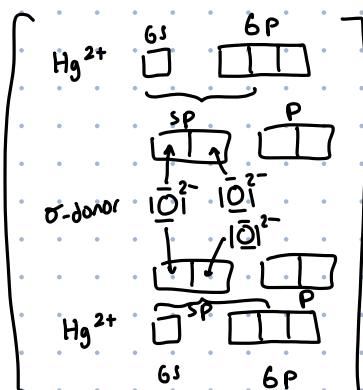
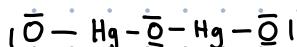
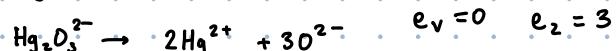
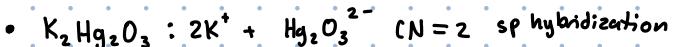
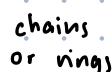
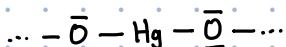
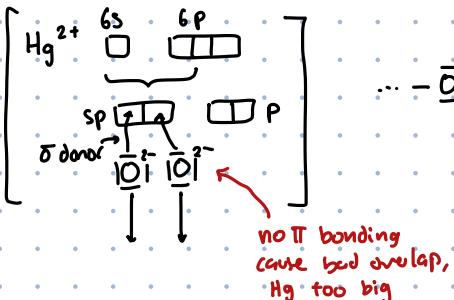
10.



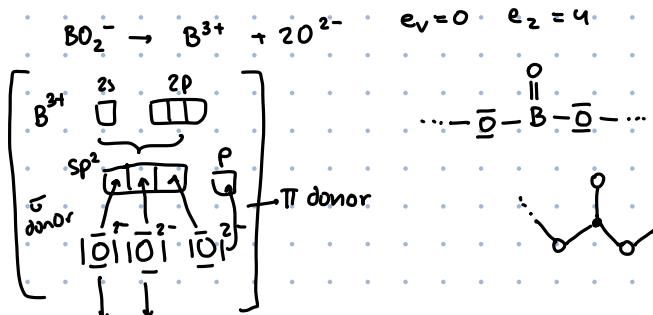


$N^{st}$  is smaller so there is better overlap with the ligand orbitals leading to stronger bonds. Stronger bonds create more repulsion between them, leading to prefer a larger angle.

A lone pair occupies more space around the word center than a ligand because it is not shared. Hence, the lone pair in  $\text{SO}_2$  pushes the 2 oxygens closer together. In  $\text{SO}_3$  all oxygens are equivalent so they have bond angle  $120^\circ$ .

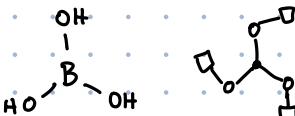
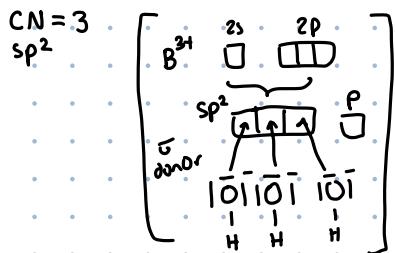


- $\text{KBO}_2$  :  $\text{K}^+ + \text{BO}_2^-$  CN=3 sp<sup>2</sup>

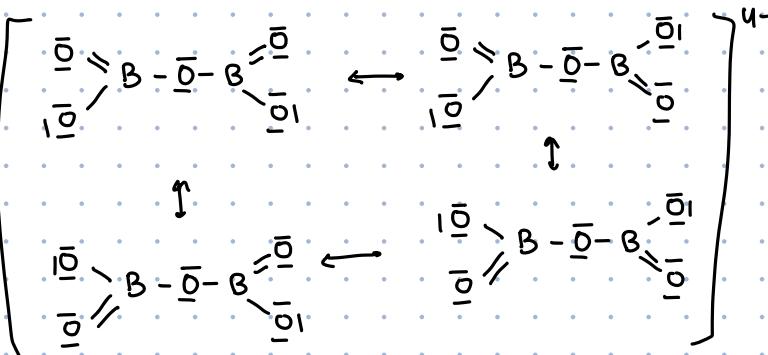
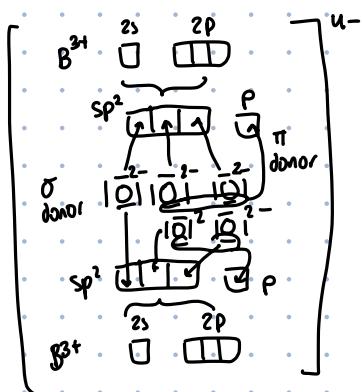
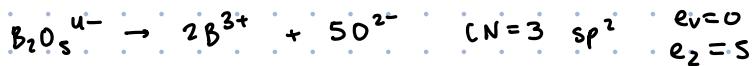


two shared to give  $\text{BO}_2$

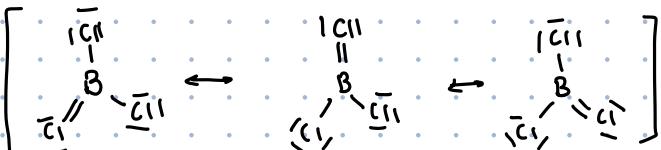
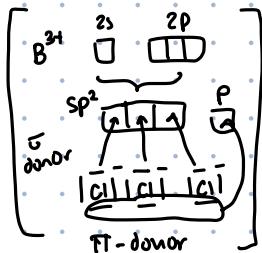
- $B(OH)_3$ :  $B^{3+} + 3OH^- \quad e_V=0 \quad e_2=3$



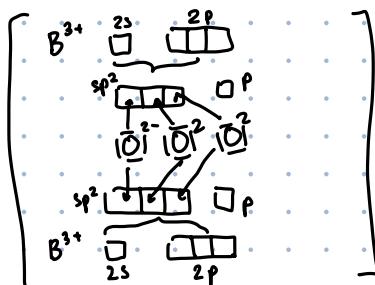
•  $K_4B_2O_5$  :  $4K^+$  +  $B_2O_5^{4-}$



- $\bullet \text{ BCl}_3 \rightarrow \text{B}^{3+} + 3\text{Cl}^- \quad \text{CN}=3 \quad \text{sp}^2 \quad e_1=0 \\ e_2=3$

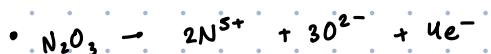
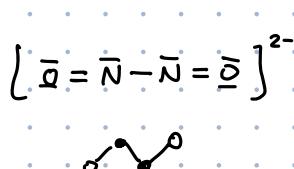
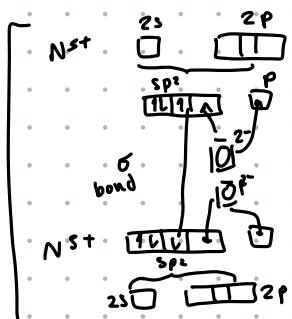
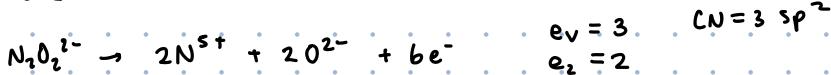
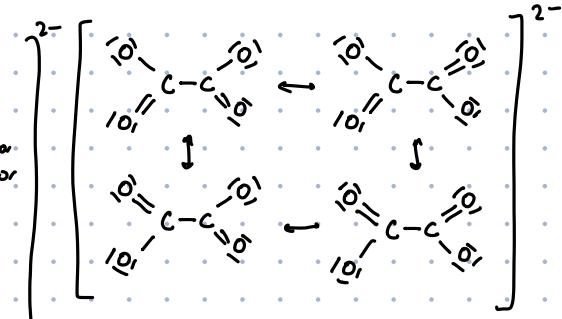
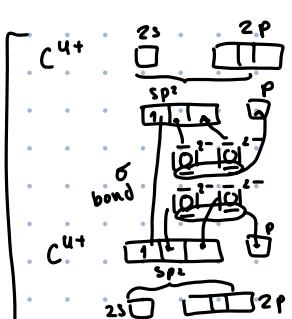
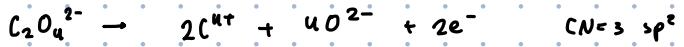


- $B_2O_3 \rightarrow 2B^{3+} + 3O^{2-}$       CN = 3       $e_v = 0$   
 $e_2 = 3$

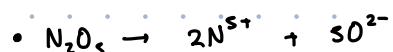
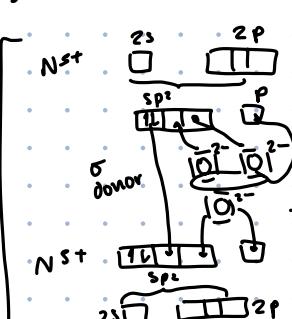




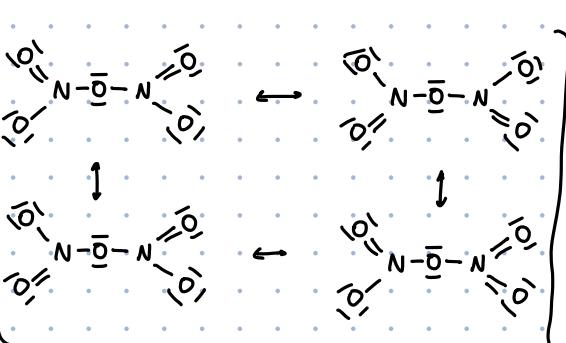
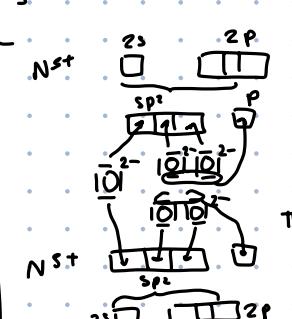
$$e_V=2 \quad e_2=4$$

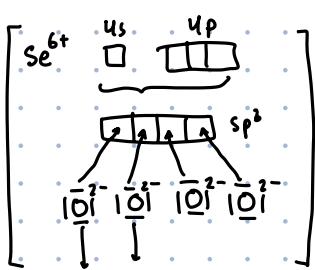


$$e_V=2 \quad e_2=3 \quad \text{CN}=3 \text{ sp}^2$$



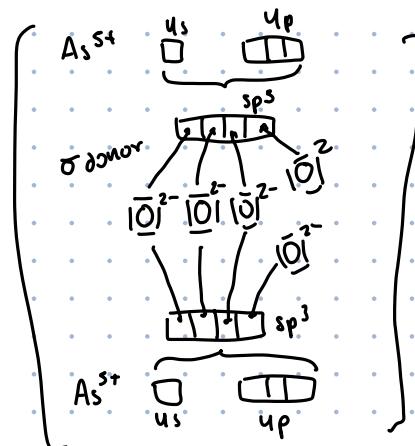
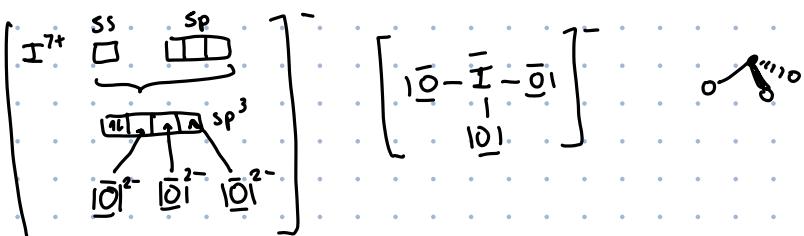
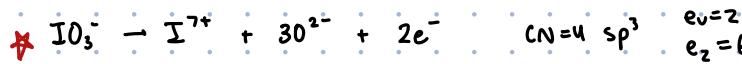
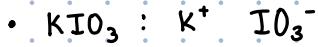
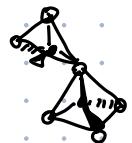
$$\text{CN}=3 \text{ sp}^2 \quad e_V=0 \quad e_2=5$$





$CN=4 \quad sp^3$

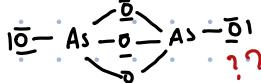
$e_v=0$   
 $e_z=6$



$CN=4 \quad sp^3$

$e_v=0$   
 $e_z=5$

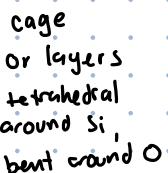
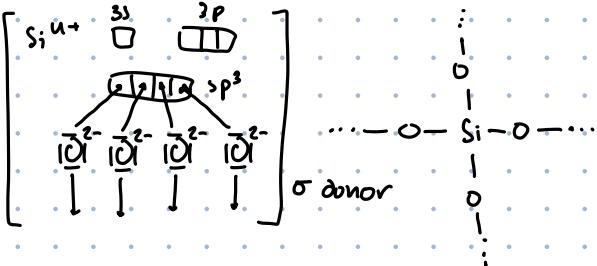
Not mega sure



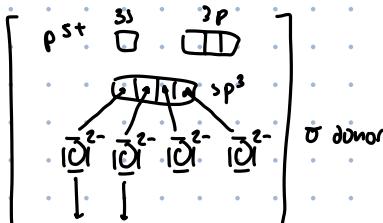
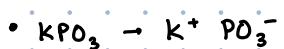
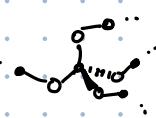
2 tetrahedra sharing a face?



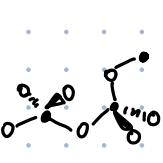
$CN=4 \quad sp^3 \quad e_v=0 \quad e_z=2$



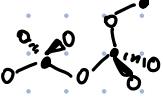
cage or layers tetrahedral around Si bent around O

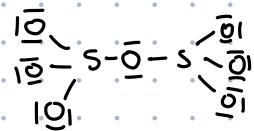
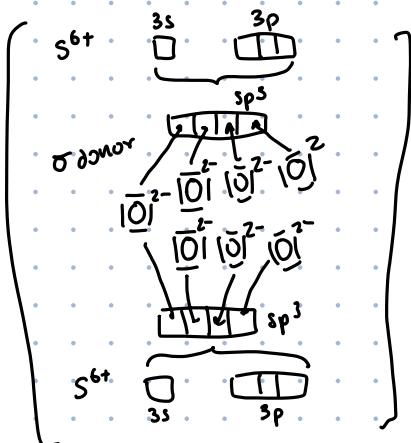
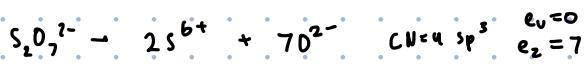
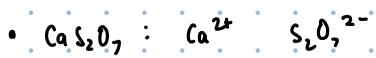


$\sigma$  donor

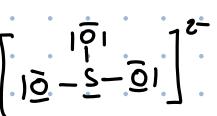
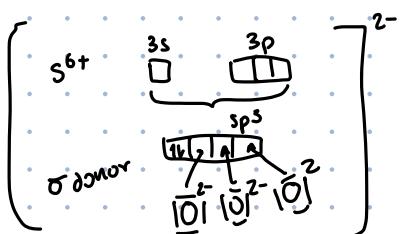
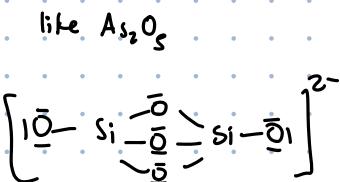
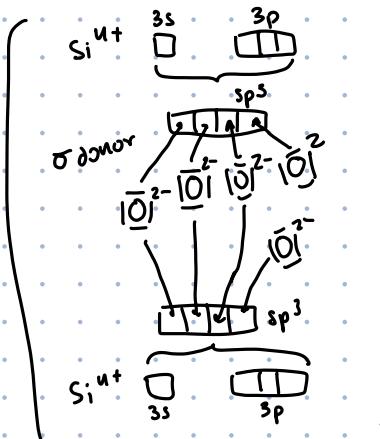
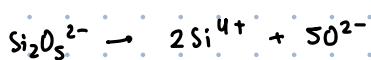
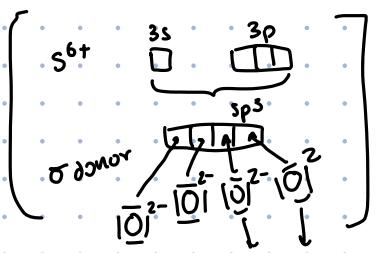


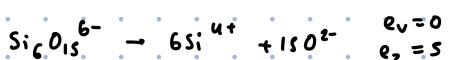
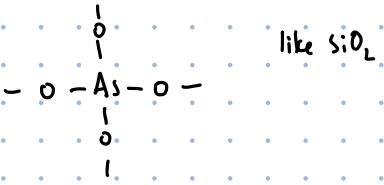
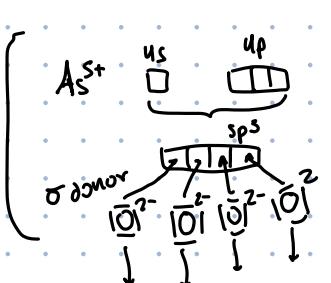
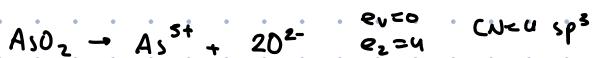
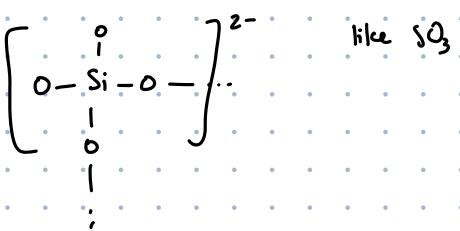
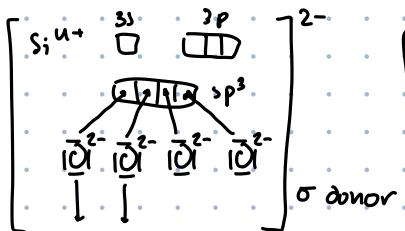
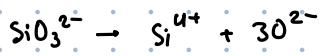
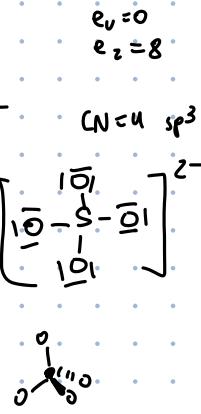
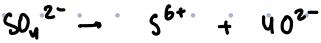
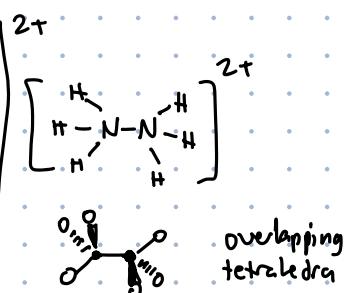
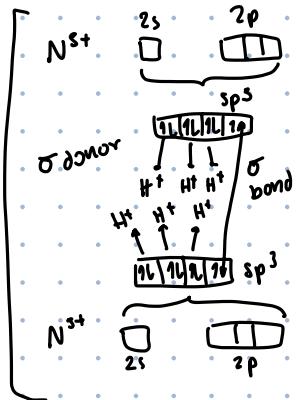
tetrahedra sharing vertex



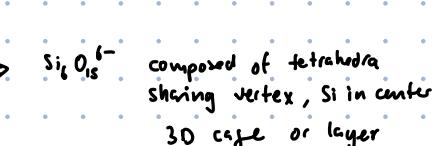
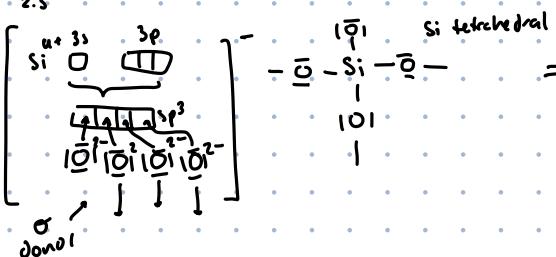
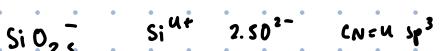


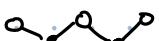
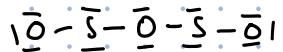
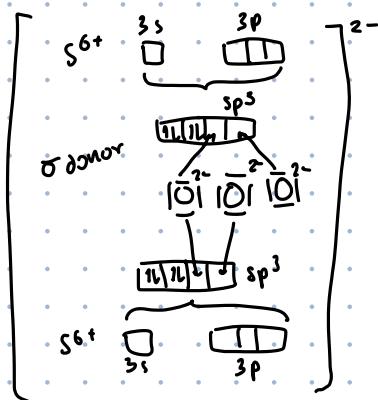
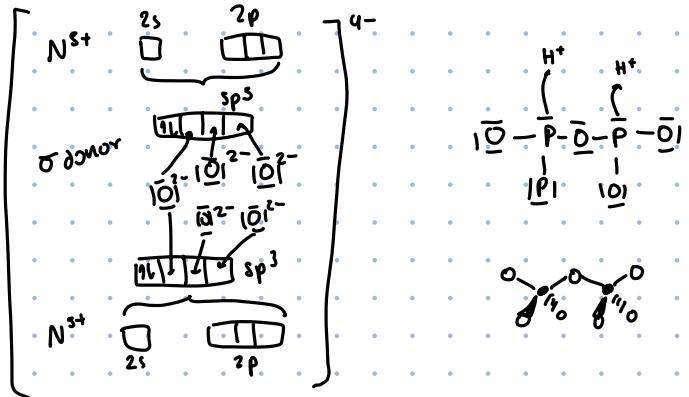
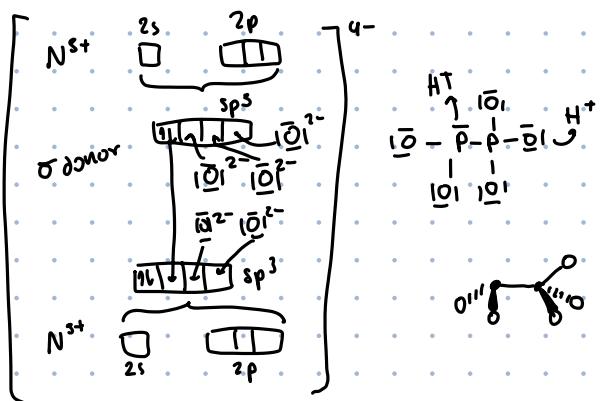
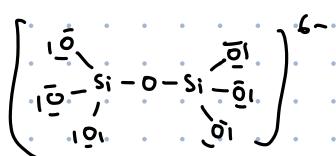
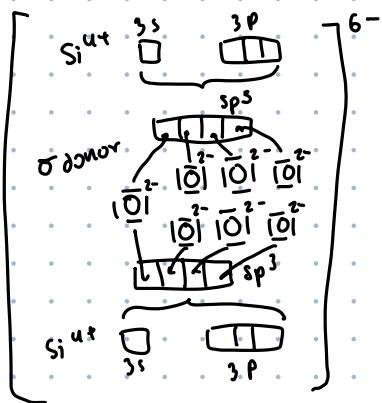
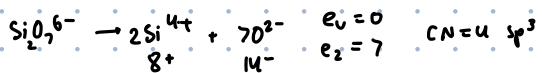
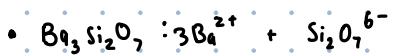
tetrahedra connected at vertex

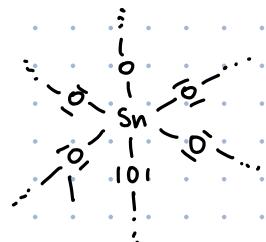
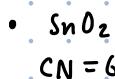
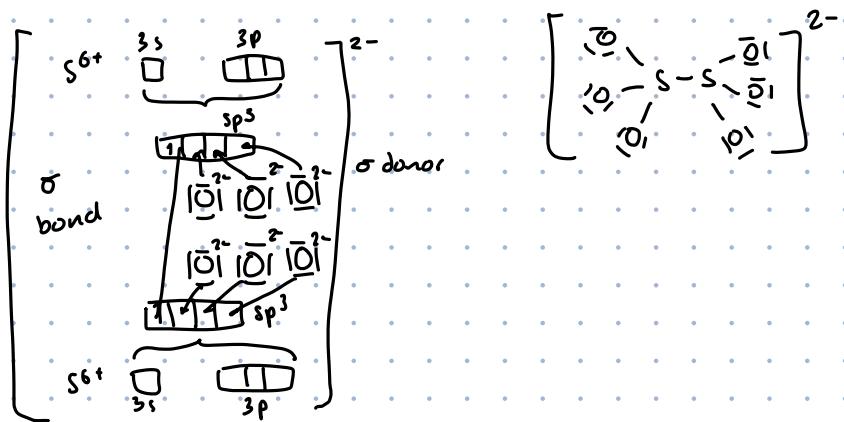
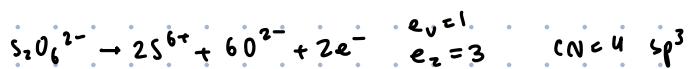
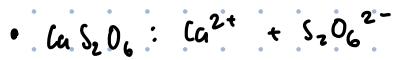
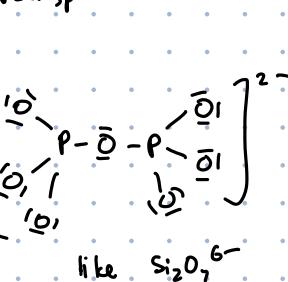
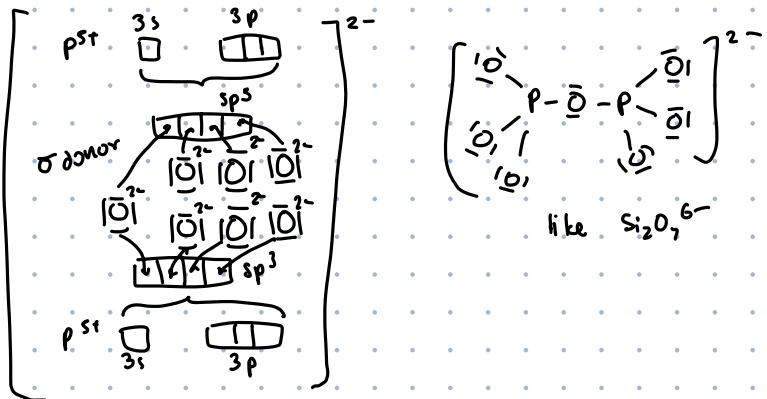
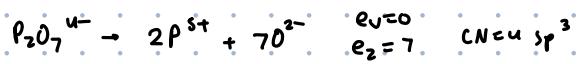




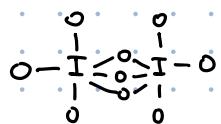
| simplify by dividing by 6





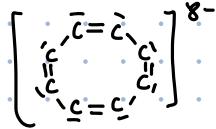


But  $\text{SnO}_3$  how??

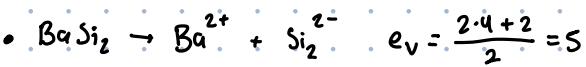
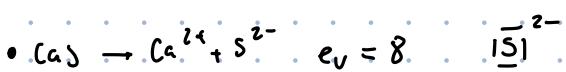


13.

- $KP \rightarrow K^+ + P^{3-}$   $e_v = 6$   $CN = 2$  forms chains or rings  $\cdots -\overline{P} - \overline{P} - \overline{P} - \cdots$
- $CaP \rightarrow Ca^{2+} + P^{3-}$   $e_v = 7$   $CN = 1$  forms  $[\overline{P} - \overline{P}]^{2-}$
- $C_8H_8 \rightarrow C_8^{8-} + 8H^+$   $e_v = \frac{8 \cdot 4 + 8}{8} = 5$ 
  - $CN = 2$  8 membered ring w/ alternating single & double bonds
  - OR long chains
- $NaSi \rightarrow Na^+ + Si^{4-}$   $e_v = 5$ 
  - $CN = 2$  chains or rings
  - $CN = 3$  2D layers or 3D cages
  - $CN = 4$  3D cages



- $CaSi \rightarrow Ca^{2+} + Si^{2-}$   $e_v = 6$   $CN = 2$  chains or rings

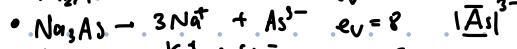
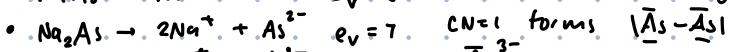


- $CN = 2$  chains or rings  $\quad - \overline{Si} = \overline{Si}^-$
- $CN = 3$  2D layers or 3D cages
- $CN = 4$  3D cages

- $KBe \rightarrow K^+ + Be^{2-}$   $e_v = 5$

- $CN = 2$  chains or rings
- $CN = 3$  2D layers or 3D cages
- $CN = 4$  3D cages

- $NaAs \rightarrow Na^+ + As^{3-}$   $e_v = 6$   $CN = 2$  chains or rings



- $CN = 2$  chains or rings

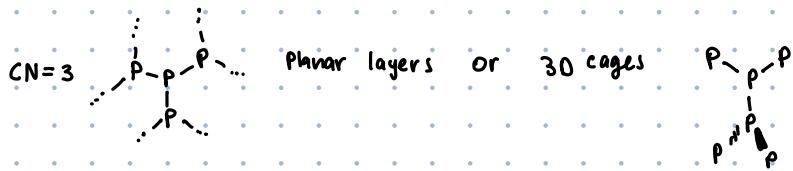
- $CN = 3$  2D layers or 3D cages
- $CN = 4$  3D cages

- $K_2Si \rightarrow 2K^+ + Si^{2-}$   $e_v = 6$   $CN = 2$  chains or rings



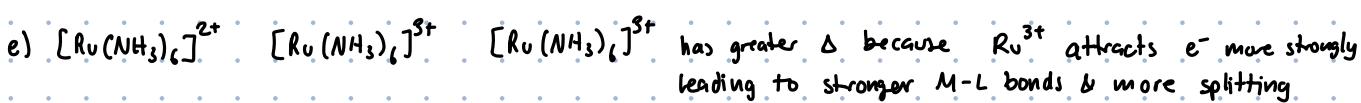
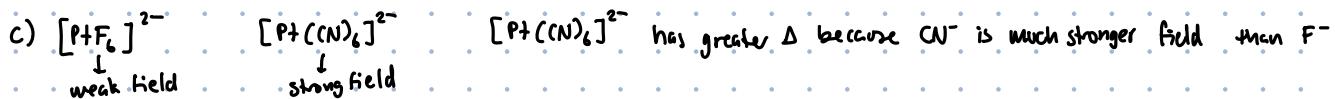
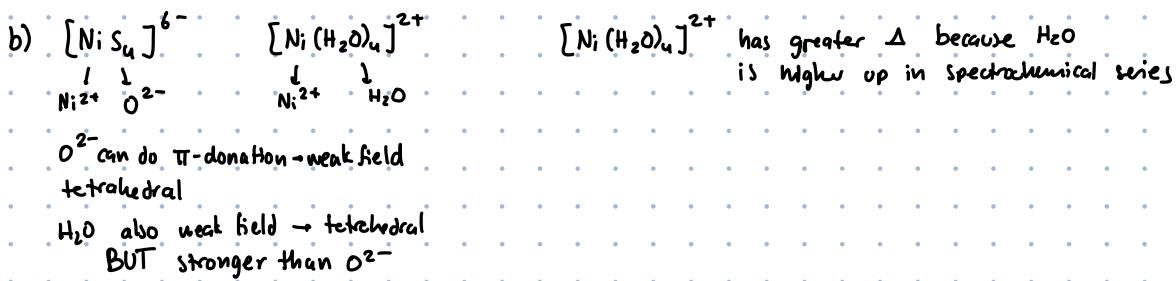
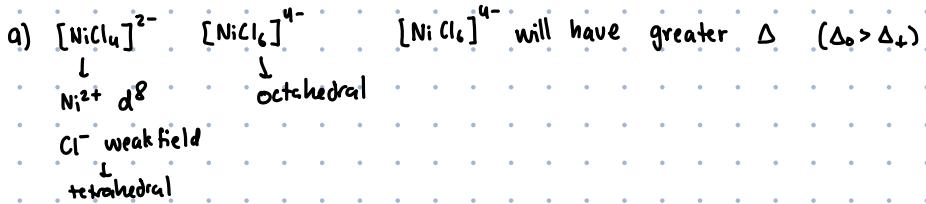
14.

- $\text{P}^0 \quad e_v = 5 \quad \text{CN} = 2 \text{ chains or rings}$

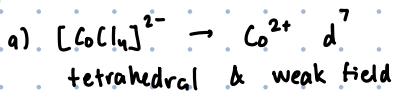


- $\text{Si}^0 \quad e_v = 4 \quad \begin{array}{l} \text{CN} = 4 \\ \text{CN} = 3 \\ \text{CN} = 2 \end{array} \quad \begin{array}{l} \text{3D cage, tetrahedral around each Si (diamond like)} \\ \text{planar or 3D cages} \\ \text{rings or chains} \end{array}$
- $\text{C}^0 \quad e_v = 4 \quad \begin{array}{l} \text{CN} = 4 \\ \text{CN} = 3 \\ \text{CN} = 2 \end{array} \quad \begin{array}{l} \text{3D cage, tetrahedral (diamond)} \\ \text{planar or 3D cages (graphene, graphite)} \\ \text{rings or chains} \end{array}$
- $\text{S}^0 \quad e_v = 6 \quad \text{CN} = 2 \quad \text{rings or chains}$
- $\text{Se}^0 \quad e_v = 6 \quad \text{CN} = 2 \quad \text{chains or rings}$
- $\text{Ge}^0 \quad e_v = 4 \quad \begin{array}{l} \text{CN} = 4 \\ \text{CN} = 3 \\ \text{CN} = 2 \end{array} \quad \begin{array}{l} \text{3D cage, tetrahedral} \\ \text{planar or 3D cages} \\ \text{rings or chains} \end{array} \quad \left. \begin{array}{l} \text{He didn't mention these} \\ \text{in review, possible?} \end{array} \right\}$
- $\text{As}^0 \quad e_v = 5 \quad \begin{array}{l} \text{CN} = 3 \\ \text{CN} = 2 \end{array} \quad \begin{array}{l} \text{2D layers or 3D cages} \\ \text{chains or rings} \end{array}$
- $\text{B}^0 \quad e_v = 3 \quad \text{CN} = 3 \quad \text{2D layers or 3D cages}$

15.

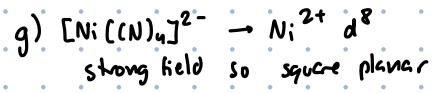


16.

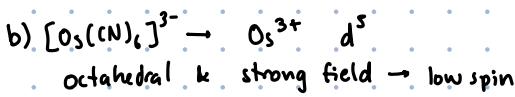


$$\begin{array}{c} \frac{1}{d_{yz}} \frac{1}{d_{yz}} \frac{1}{d_{xy}} \\ \frac{1}{d_{z^2}} \frac{1}{d_{z^2-y^2}} \end{array} \quad t_{2g}$$

paramagnetic

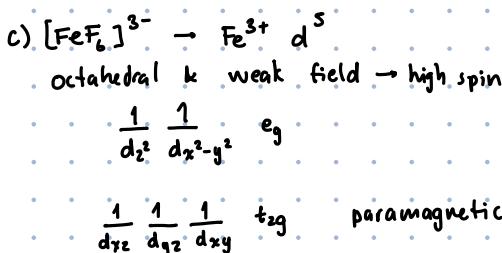


$$\begin{array}{c} \overline{d_{x^2-y^2}} \\ \frac{1}{d_{xy}} \\ \frac{1}{d_{z^2}} \end{array} \quad \begin{array}{c} \frac{1}{d_{xz}} \frac{1}{d_{yz}} \\ \frac{1}{d_{xy}} \end{array} \quad \begin{array}{c} \text{diamagnetic} \\ \text{diamagnetic} \end{array}$$

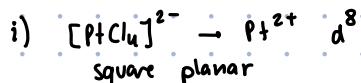


$$\begin{array}{c} \overline{d_{z^2}} \quad \overline{d_{x^2-y^2}} \\ \frac{1}{d_{z^2}} \end{array} \quad e_g$$

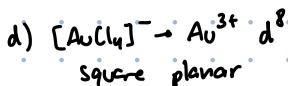
paramagnetic



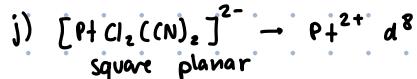
$$\begin{array}{c} \frac{1}{d_{xz}} \quad \frac{1}{d_{yz}} \quad \frac{1}{d_{xy}} \\ \frac{1}{d_{x^2-y^2}} \quad \frac{1}{d_{z^2}} \end{array} \quad t_{2g} \quad \begin{array}{c} \text{diamagnetic} \\ \text{diamagnetic} \end{array}$$



$$\begin{array}{c} \overline{d_{x^2-y^2}} \\ \frac{1}{d_{xy}} \\ \frac{1}{d_{z^2}} \end{array} \quad \begin{array}{c} \frac{1}{d_{xz}} \frac{1}{d_{yz}} \\ \frac{1}{d_{xy}} \end{array} \quad \begin{array}{c} \text{diamagnetic} \\ \text{diamagnetic} \end{array}$$



$$\begin{array}{c} \overline{d_{x^2-y^2}} \\ \frac{1}{d_{xy}} \\ \frac{1}{d_{z^2}} \end{array} \quad \begin{array}{c} \frac{1}{d_{xz}} \frac{1}{d_{yz}} \\ \frac{1}{d_{xy}} \end{array} \quad \begin{array}{c} \text{diamagnetic} \\ \text{diamagnetic} \end{array}$$



$$\begin{array}{c} \overline{d_{x^2-y^2}} \\ \frac{1}{d_{xy}} \\ \frac{1}{d_{z^2}} \end{array} \quad \begin{array}{c} \frac{1}{d_{xz}} \frac{1}{d_{yz}} \\ \frac{1}{d_{xy}} \end{array} \quad \begin{array}{c} \text{diamagnetic} \\ \text{diamagnetic} \end{array}$$

