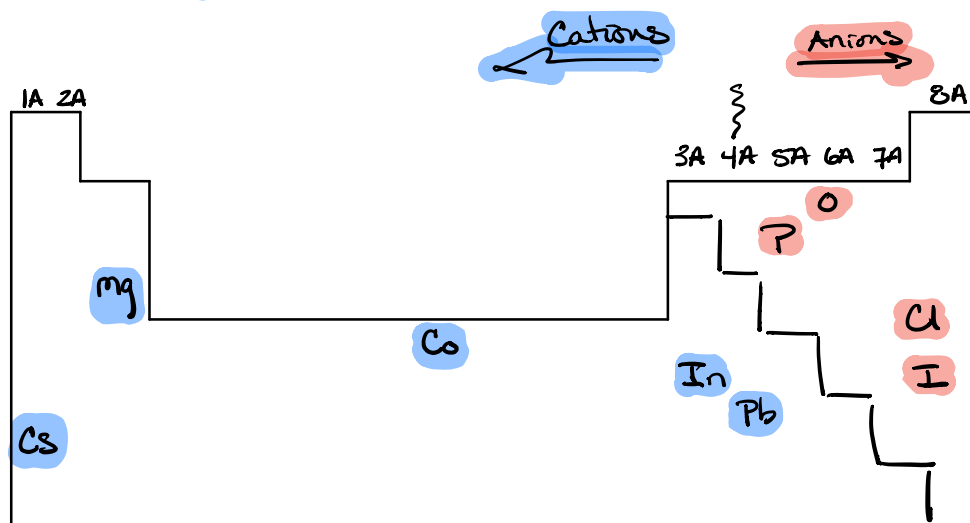


## Chapter 4 Homework Answer key

4.1

3) Which of the following atoms would be expected to form negative ions in binary ionic compounds and which would be expected to form positive ions.

P, I, Mg, Cl, In, Cs, O, Pb, Co



5) Predict the charge on the monatomic ions formed from the following atoms in binary ionic compounds

a) P Group 5A  $P^{3-}$

d) O Group 6A  $O^{2-}$

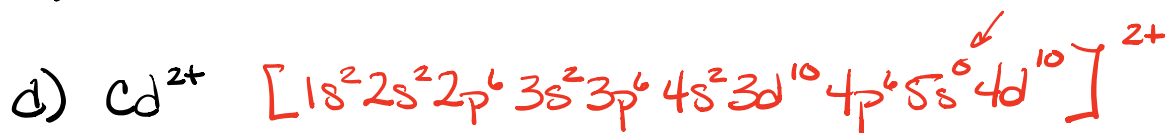
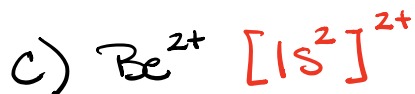
b) Mg Group 2A  $Mg^{2+}$

e) Cl Group 7A  $Cl^{-}$

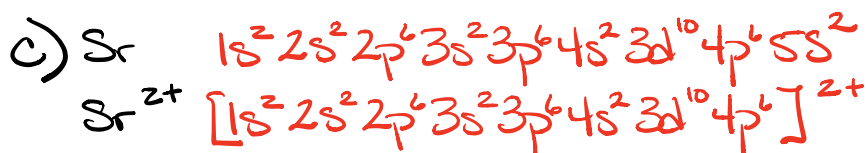
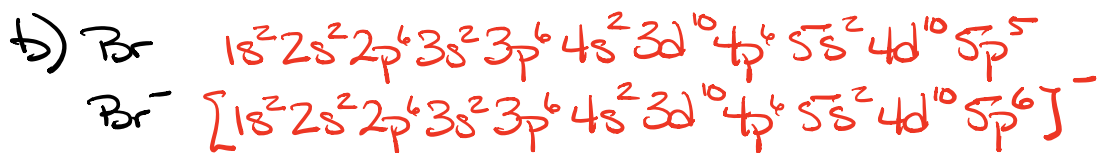
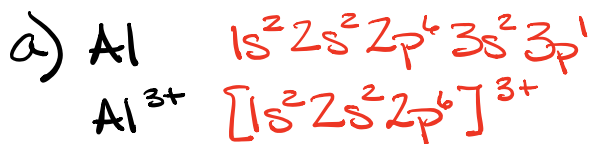
c) Al Group 3A  $Al^{3+}$

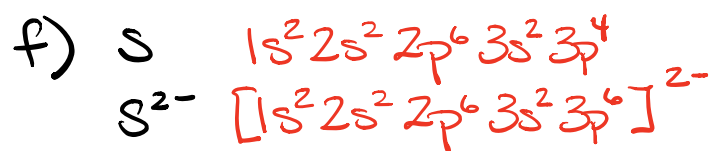
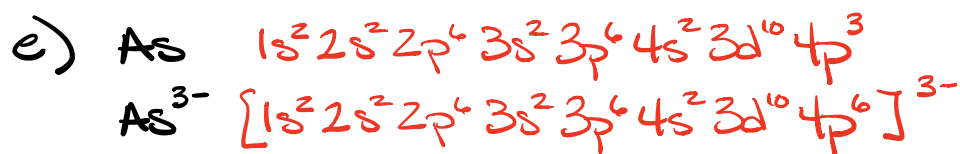
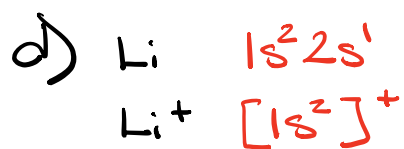
f) Cs Group 1A  $Cs^{+}$

7) Write electronic Configurations for each of the following ions:



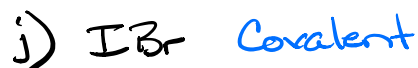
9) Write out the full electronic Configuration for each of the following atoms and for the monatomic ion found in binary ionic Compounds containing the element.



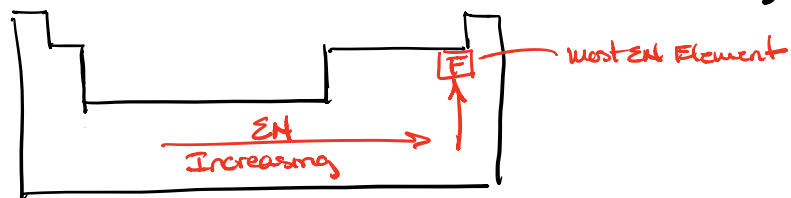


13) Predict which of the following compounds are ionic and which are covalent, based on the location of their constituent atoms in the periodic table:

Look for the metals. Metal = Ionic



15) From its position in the periodic table, determine which atom in each pair is more electronegative:



a) Br or Cl

b) N or O

c) S or O

d) P or S

e) Si or N

f) Ba or P

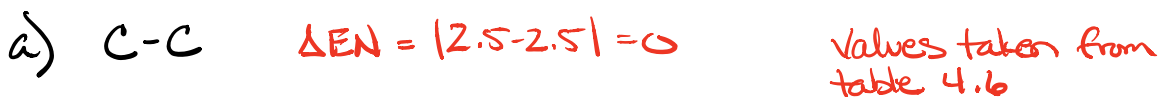
g) N or K



17) From their positions in the periodic table arrange the atoms in each of the following series in order of increasing electronegativity:



20) Which is the most polar bond?



21) Identify the more polar bond in each of the following pairs of bonds:

a) HF or HCl

b) NO or CO

c) SH or OH

d) PCl or SCl

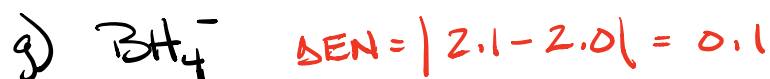
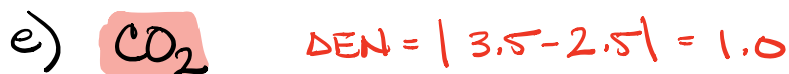
e) CH or NH

f) SO or PO

g) CN or NN

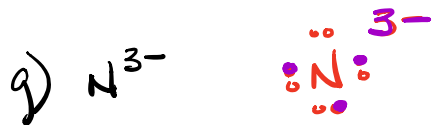
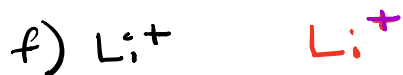
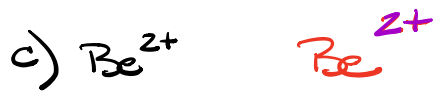
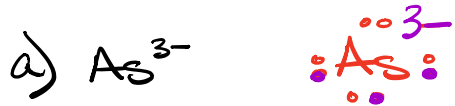
Looking for the larger  $\Delta EN$ ,  
You can use the table 4.6  
or periodic table trends  
to answer.

22) Which of the following molecules or ions contain polar bonds?

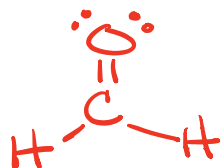


4.4

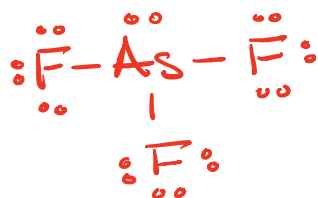
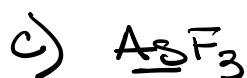
34) Write the Lewis symbols for each of the following ions:



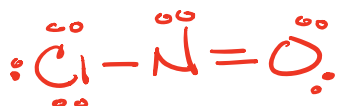
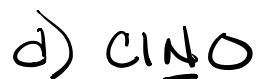
40) Write Lewis Structures for the following:



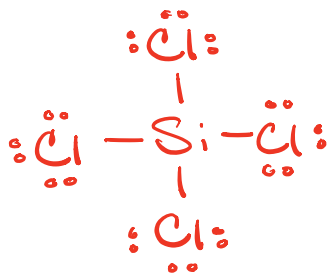
$$\begin{array}{r} \text{H } 2 \times 1 = 2 \\ \text{C } 1 \times 4 = 4 \\ \text{O } 1 \times 6 = 6 \\ \hline 12e^- \end{array}$$



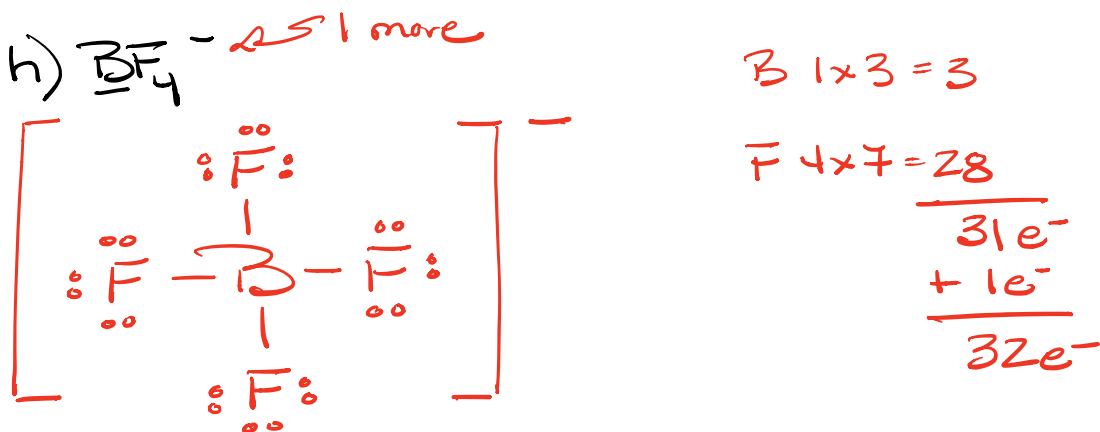
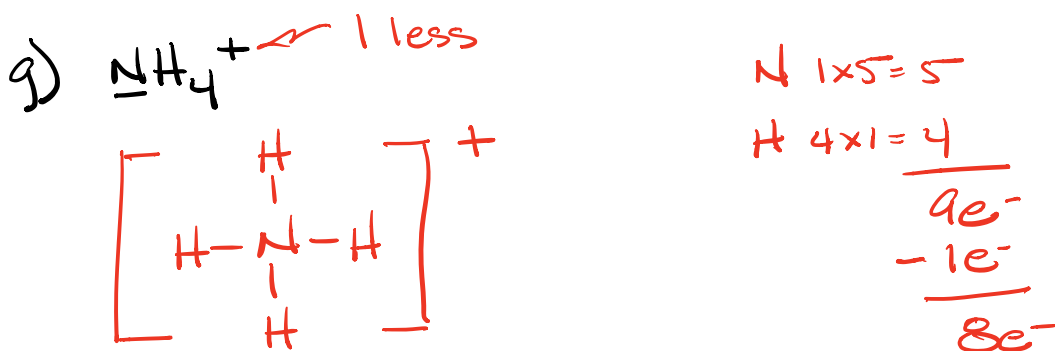
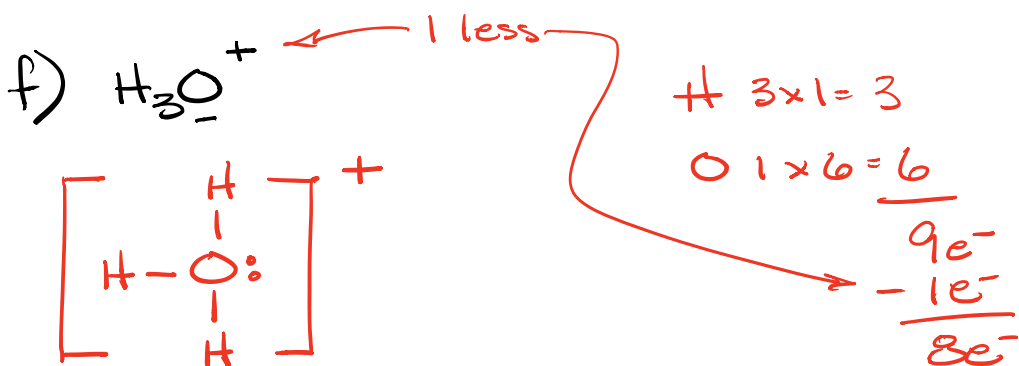
$$\begin{array}{r} \text{As } 1 \times 5 = 5 \\ \text{F } 3 \times 7 = 21 \\ \hline 26e^- \end{array}$$

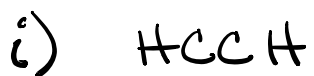


$$\begin{array}{r} \text{Cl } 1 \times 7 = 7 \\ \text{N } 1 \times 5 = 5 \\ \text{O } 1 \times 6 = 6 \\ \hline 18e^- \end{array}$$



$$\begin{array}{r} \text{Si } 1 \times 4 = 4 \\ \text{Cl } 4 \times 7 = 28 \\ \hline 32e^- \end{array}$$

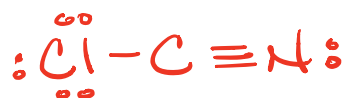




$$H \ 2 \times 1 = 2$$

$$C \ 2 \times 4 = 8$$

$$\underline{\hspace{1cm}} \\ 10e^-$$

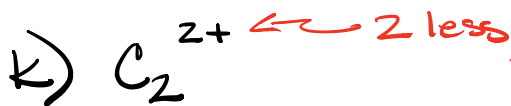


$$Cl \ 1 \times 7 = 7$$

$$C \ 1 \times 4 = 4$$

$$N \ 1 \times 5 = 5$$

$$\underline{\hspace{1cm}} \\ 16e^-$$



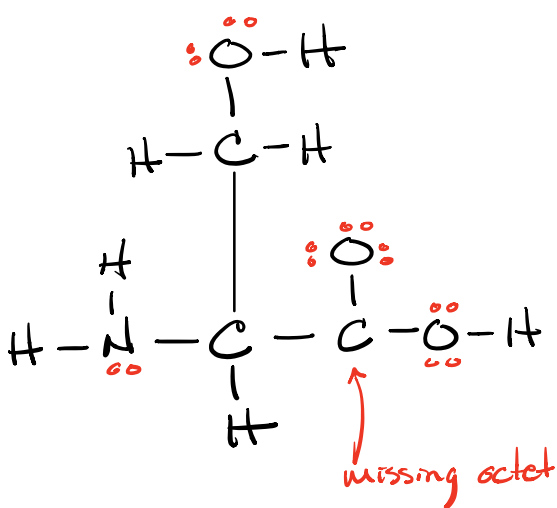
$$C \ 2 \times 4 = 8e^-$$

$$- 2e^-$$

$$\underline{\hspace{1cm}} \\ 6e^-$$

50) The arrangement of atoms in several biologically important molecules is given here. Complete the Lewis Structures of these molecules by adding multiple bonds and lone pairs. Do not add any more atoms

a) The amino acid Serine



①  $e^-$  count

$$C \quad 3 \times 4 = 12$$

$$H \quad 7 \times 1 = 7$$

$$N \quad 1 \times 5 = 5$$

$$O \quad 3 \times 6 = 18$$

$$\hline 42e^-$$

② Give more  $e^-$  to atoms (N, O) an octet

③ Count octets

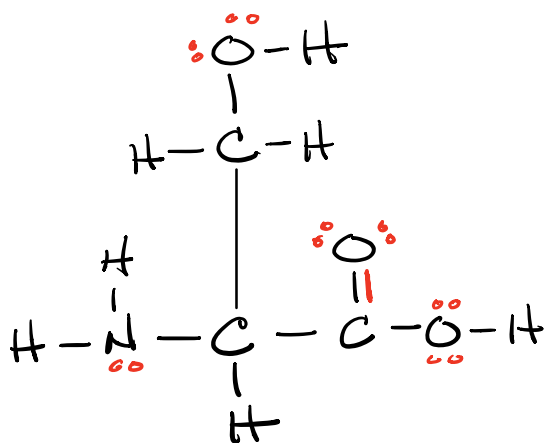
④ make double bonds

⑤ Do checks

octets ✓

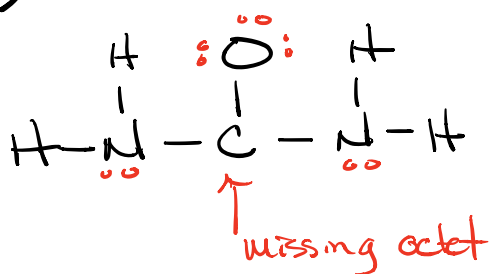
$42e^-$  ✓

formal charge ✓





b) urea



①  $e^-$  count

$$\begin{array}{r} \text{C } 1 \times 4 = 4e^- \\ \text{H } 4 \times 1 = 4e^- \\ \text{N } 2 \times 5 = 10e^- \\ \text{O } 1 \times 6 = 6e^- \\ \hline 24e^- \end{array}$$

② Give more  $e^-$  atoms  
( $\text{N}_2\text{O}$ ) an octet

③ Count octets

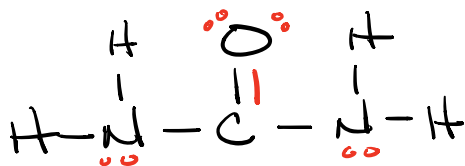
④ make double bonds

⑤ Do checks

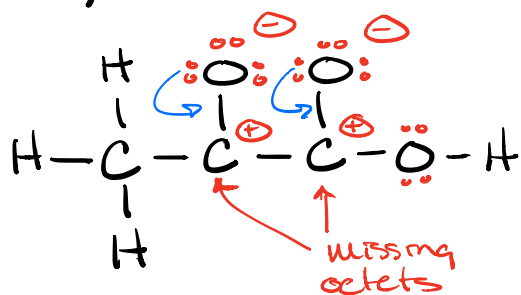
octets ✓

$24e^-$  ✓

formal charge ✓



### c) Pyruvic acid



#### ① e<sup>-</sup> count

$$\begin{array}{l} \text{C } 3 \times 4 = 12e^- \\ \text{H } 4 \times 1 = 4e^- \\ \text{O } 3 \times 6 = 18e^- \\ \hline 34e^- \end{array}$$

② Give more electrons to atoms  
an octet  $\Rightarrow$  O

③ Count octets

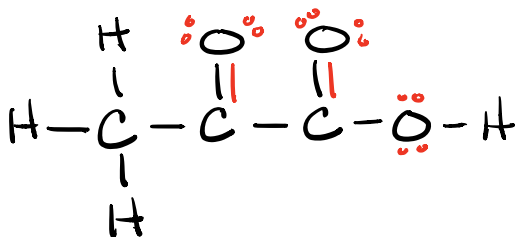
④ make double bonds

⑤ Do checks

octets ✓

34 e<sup>-</sup> ✓

formal charge ✓

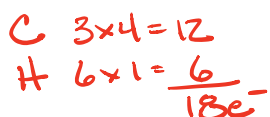


52) A compound with a mass of about 42g/mole  
 Contains 85.7% Carbon and 14.3% hydrogen.  
 Write the Lewis Structure for the molecule.

Steps

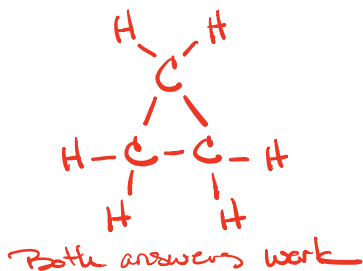
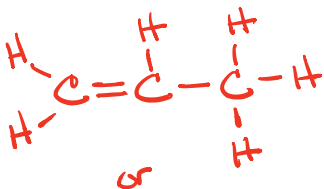
- ① % to mass
- ② mass to moles
- ③ divide by small
- ④ mult til whole (if needed)
- ⑤ Calc molar mass Empirical
- ⑥ Divide molar mass compound by molar mass empirical
- ⑦ Find Molecular Formula
- ⑧ Lewis Structure

	<u>C</u>	<u>H</u>
	%	%
	85.7%	14.3%
	mass	mass
	85.7g	14.3g
	moles	moles
	$85.7g \times \frac{1 \text{ mole}}{12.01g} =$	$14.3g \times \frac{1 \text{ mole}}{1.008g} =$
	7.135720233 mole	14.18656794 mole



Divide by small (Ratio)      1      :      2

Empirical       $CH_2$       molar mass = 14.03g/mol



$$\frac{\text{Molar Mass } 42g/\text{mole}}{\text{empirical } 14.03g/\text{mole}} = 3$$

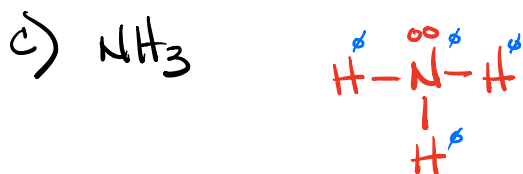
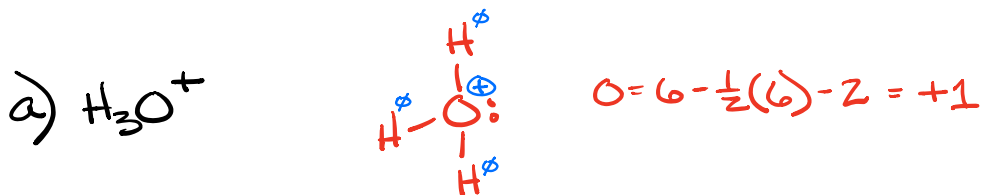
$$\text{molecular formula} = 3 \times \text{empirical} = 3 CH_2$$

$$= C_3H_6$$

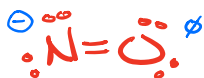
## 4.5

63) Determine the formal charge of each element in the following:

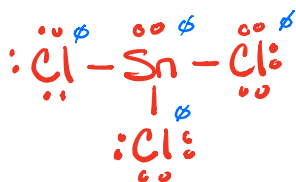
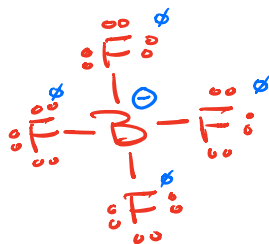
$$\text{Formal Charge} = \text{Valence } e^- - \frac{1}{2}(\text{bonding}) - \text{nonbonding}$$



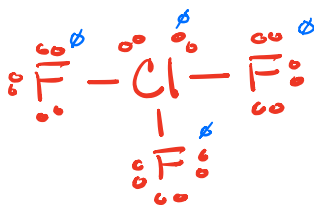
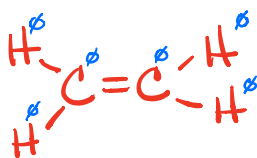
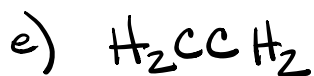
65) Calculate the formal charge of each element in the following compounds and ions:



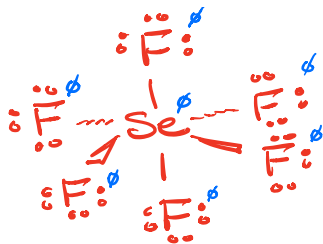
$$\begin{array}{r} 5 \\ 6 \\ \hline 12 \end{array}$$



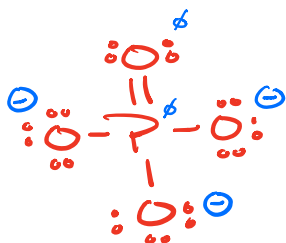
$$\begin{array}{r} \text{Sn } 1 \times 4 = 4 \\ \text{Cl } 3 \times 7 = 21 \\ \hline 25 \\ + 1 \\ \hline 26 \end{array}$$



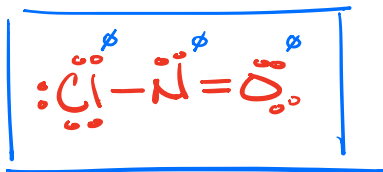
$$\begin{array}{r} \text{Cl } 1 \times 7 = 7 \\ \text{F } 3 \times 7 = 21 \\ \hline 28e^- \end{array}$$



$$\begin{array}{r} \text{Se } 1 \times 6 = 6 \\ \text{F } 6 \times 7 = 42 \\ \hline 48e^- \end{array}$$



67) Based on formal charge considerations which of the following would likely be the correct arrangement of atoms in nitrosyl chloride:  $\text{ClNO}$  or  $\text{ClON}$ ?



$$\begin{array}{r} \text{Cl } 1 \times 7 = 7 \\ \text{N } 1 \times 5 = 5 \\ \text{O } 1 \times 6 = 6 \\ \hline 18e^- \end{array}$$

Better structure due to zero formal charges!

## 4.6

75) Explain why the  $\text{H}_2\text{O}$  molecule is bent, where  $\text{H}_2\text{Be}$  is linear.



Bent  $109.5^\circ$

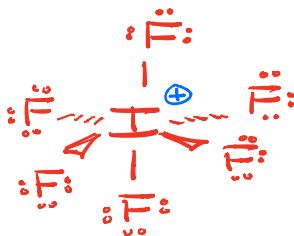


linear  $180^\circ$

The two lone pair of  $e^-$  push on the hydrogens reducing the bond angle in  $\text{H}_2\text{O}$  to  $109.5^\circ$ .  $\text{H}_2\text{Be}$  has no lone pair of  $e^-$ .

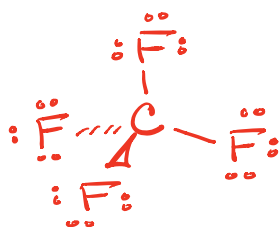
82) Identify the  $e^-$  pair geometry and molecular geometry of each of the following molecules or ions:

a)  $\text{IF}_6^+$

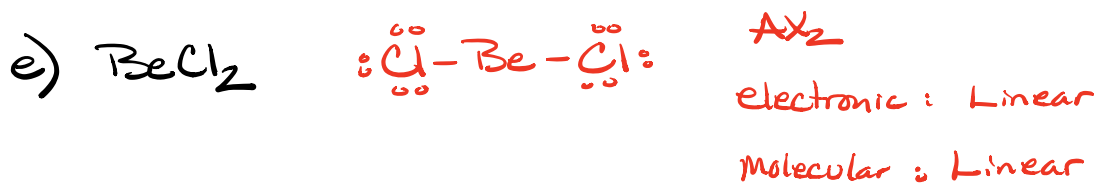


$\text{AX}_6$   
electronic: octahedral  
molecular: octahedral

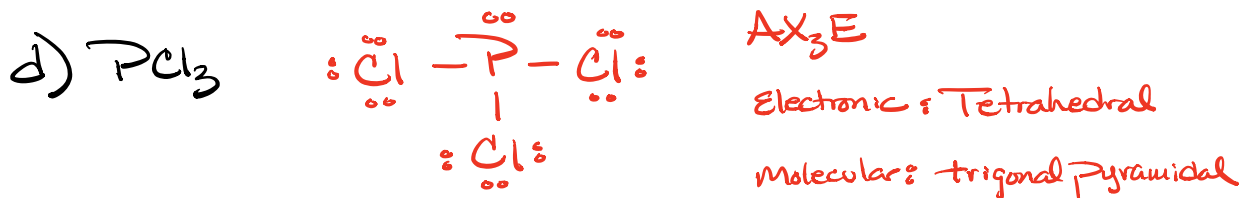
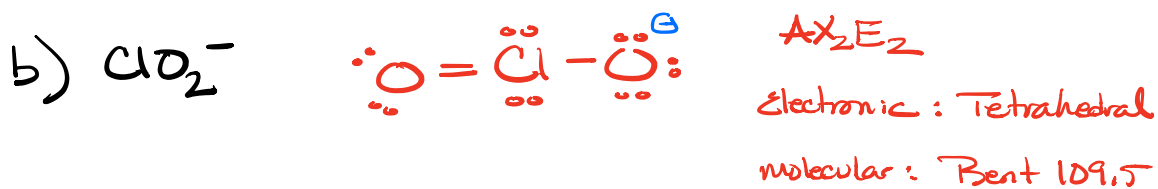
b)  $\text{CF}_4$



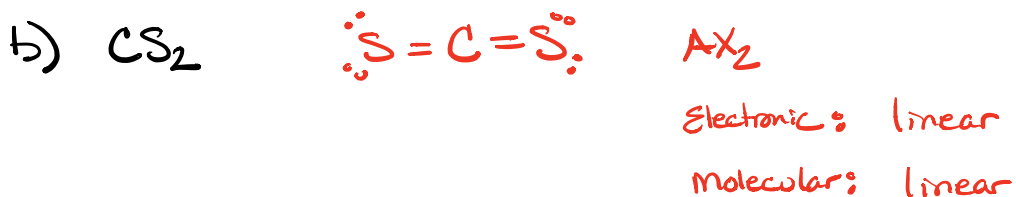
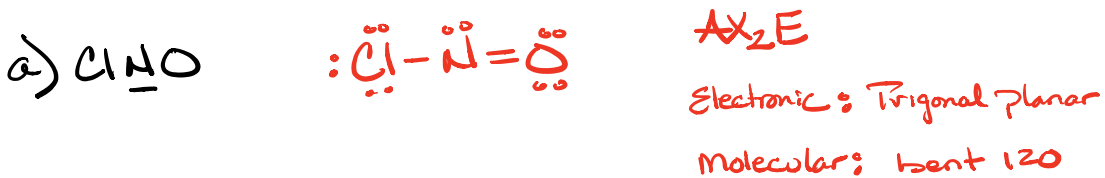
$\text{AX}_4$   
electronic: Tetrahedral  
molecular: Tetrahedral



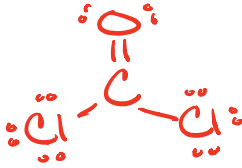
83) Identify the  $e^-$  pair geometry and molecular geometry of each of the following molecules or ions:



85) Identify the  $e^-$  pair geometry and molecular geometry of each of the following molecules or ions:



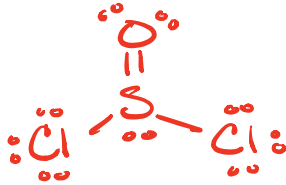
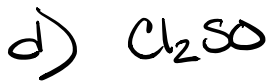




$\text{AX}_3$

Electronic: Trigonal planar

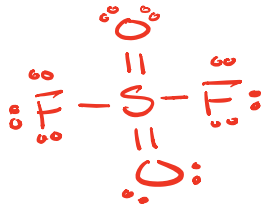
molecular: Trigonal planar



$\text{AX}_3\text{E}$

Electronic: Tetrahedral

molecular: Trigonal pyramidal

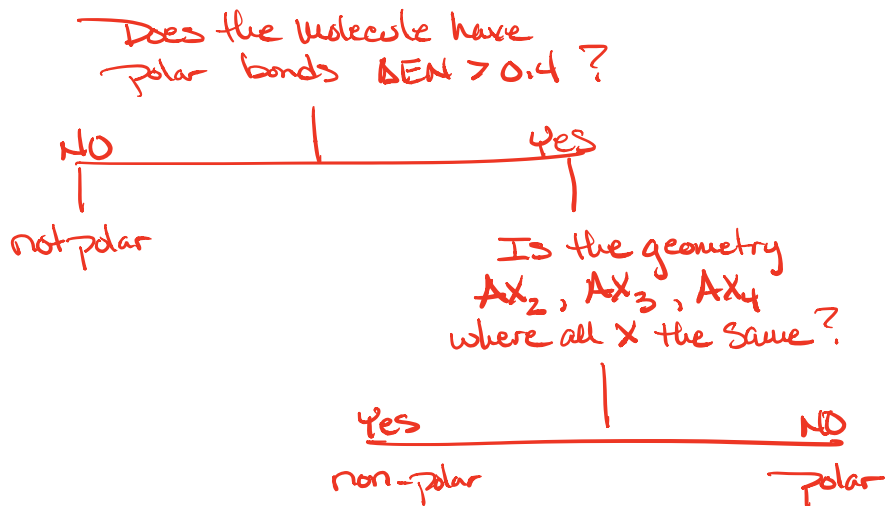


$\text{AX}_4$

Electronic: Tetrahedral

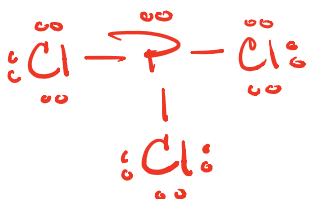
molecular: Tetrahedral

87) Which of the following molecules and ions contain polar bonds? Which of these are polar?





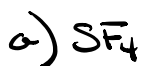
$\Delta \text{EN} = 3.5 - 3.0 = 0.5 \Rightarrow \text{polar}$



$\Delta \text{EN} = 3.0 - 2.1 = 0.9 \Rightarrow \text{polar}$



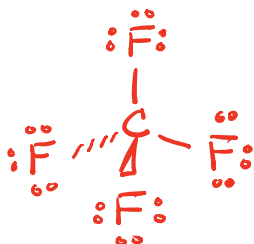
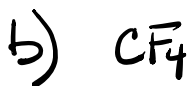
90) Identify molecules with a dipole moment:



This is the see-saw geometry from the trigonal bipyramidal family. Not one we need to know but we can extend our concept to cover it.

Lone pair breaks

symmetry. Expectation

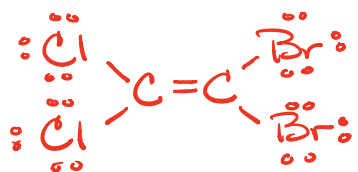
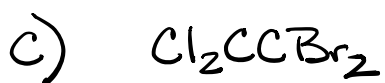


$\text{C-F}$  polar

$\text{AX}_4$  Tetrahedral

$\Rightarrow$  Symmetrical

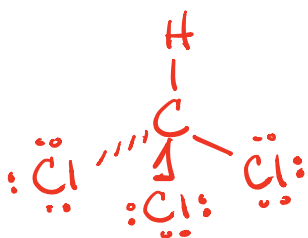




$\text{C-Br}$   $2.8 - 2.5 = 0.3$  non-polar

$\text{C-Cl}$   $3.0 - 2.5 = 0.5$  polar

Polar bonds } Polar molecule  
asymmetric }

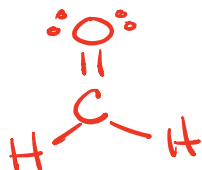
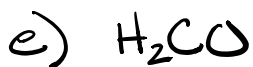


$\text{AX}_2$

$\text{C-H}$   $2.5 - 2.1 = 0.4$  non-polar

$\text{C-Cl}$   $3.0 - 2.5 = 0.5$  polar

Polar bonds } molecule polar  
asymmetric }



$\text{C-O}$   $3.5 - 2.5 = 1.0$  polar

$\text{C-H}$   $2.5 - 2.1 = 0.4$  non-polar

Polar bond } Polar molecule  
asymmetric }