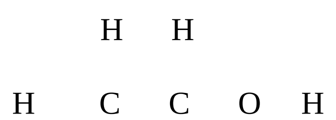
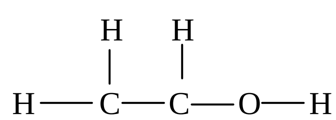
STEPS FOR DRAWING LEWIS STRUCTURES

1. Given the molecular formula, add up the valence electrons in the atoms.
   Example: C_2H_4O $2(4) + 4(1) + 1(6) = 1$
   Note: In the case of an ion if it has a "+" charge subtract that number from the total valence electrons. If it has a "-" charge, add that number to the total valence electrons. Example: NH_4^+ has 8 valence electrons (5 + 4 – 1) and NO_3^- has 24 valence electrons (5 + 18 + 1).

2. Arrange the atoms with one or two central atoms and the others around it.
   a. H atoms are always on the outside because they always only have 1 bond.
   b. O atoms are usually on the outside (not central) unless combined with H like H_2O
   c. C atoms are always a central atom

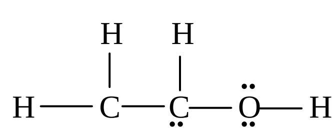


3. Connect the atoms with lines (bonds) to the central atom.



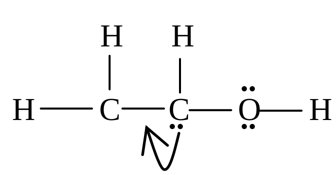
4. Subtract the bonded electrons (2 per line) from the total valence electrons: $18 – 6(2) = 6$

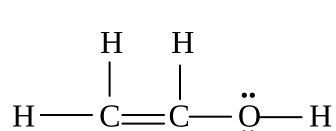
5. Place these extra electrons around outside atoms until they have a complete octet, then put the remainder on inside atoms. In this case, put the 4 electrons around the oxygen atom and two electrons on one carbon atom. Always place electrons around atoms in pairs.



6. Count electrons around each atom to be sure there is a complete octet, except for H which only has a duet. One of the carbon atoms does not have a complete octet.

7. If one or more of the central atoms do not have a complete octet then use some of the non-bonding electron pairs to make a bonding pair (i.e., make multiple bonds) so that that all atoms end up with complete octets.





8. Recount electrons around atoms to be sure all have a complete octet. Also count bonding and non-bonding electrons and make sure they equal the total number of valence electrons you started with.

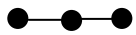
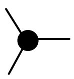
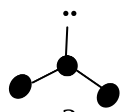
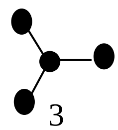
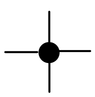
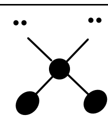
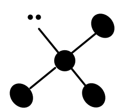
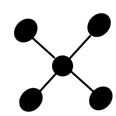
    All atoms have complete octets.

    bonding electrons = 14
    lone pairs = 4
    total = 18 , the same as the valence electrons.

9. The Lewis structure is finished and it is correct!

10. Some other considerations are the usual bonding patterns for various elements:
    a. H always has 1 bond and never any lone pairs. It only has a duet of electrons.
    b. C always has 4 bonds. They can be 4 single, 1 double and 2 single, 1 triple and 1 single. Carbon is ALWAYS a central atom and NEVER has any lone pairs.
    c. F always has 1 bond and 3 lone pairs and is ALWAYS an outside atom.
    d. Cl, Br and I usually have 1 bond and 3 lone pairs but can have other bonding arrangements depending on the compound.
    e. O usually has 2 bonds and 2 lone pairs. The two bonds can be 2 single bonds or 1 double bond. It is usually an outside atom.
    f. N usually has 3 bonds and 1 lone pair. The three bonds can be 3\2 single bonds or 1 double and 1 single bond or 1 triple bond. It is usually an outside atom.

SUMMARY OF VSEPR MODEL

TOTAL ELECTRON GROUPS *(Electron Group Geometry)*	2 bonding groups	3 bonding groups	4 bonding groups
 2 linear Bond angle: 180^o	 2 linear 180^o CO_2		
 3 trigonal planar Bond angle: 120^o	 2 bent 120^o NO_2^-	 3 trigonal planar 120^o BF_3	
 4 tetrahedral Bond angle: 109.5^o	 2 bent 109.5^o H_2O	 3 trigonal pyramid 109.5^o NH_3	 4 tetrahedral 109.5^o CH_4

BONDING ELECTRON GROUPS
(Molecular Geometry)

Molecular Polarity

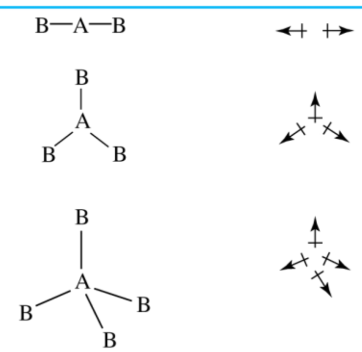
Are there any polar bonds?

NO → Molecule is non-polar!

YES → *If the bond polarity is…*

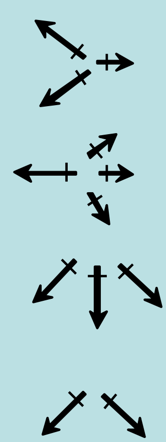
Shape	the same	different
	the molecular polarity is…	
Linear	non-polar	polar
Trigonal planar	non-polar	polar
Tetrahedral	non-polar	polar
Trigonal pyramid	polar	polar
Bent	polar	polar

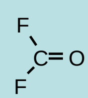
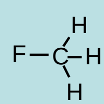
Examples of non-polar molecules



Type	Cancellation of Polar Bonds	Example
Linear molecules with two identical bonds		CO_2
Trigonal planar molecules with three identical bonds		SO_3
Tetrahedral molecules with four identical bonds		CH_4

Examples of polar molecules



Shape	polar bonds do not cancel	EXAMPLE
Linear molecules with different bonds		O=C=S
Trigonal planar molecules with different bonds		
Tetrahedral molecules with different bonds		
Trigonal pyramid molecules with identical bonds		NH_3
Bent molecules with identical bonds		H_2O