Lewis Structures of Compounds

Drawing correct Lewis structures requires practice. You need to become very comfortable drawing these, because we will use them extensively in organic chemistry. Here are some steps to get you started:

1) Find the number of valence electrons

Add the number of valence electrons for each atom

For each negative charge, add an electron

For each positive charge, subtract an electron

For COS_2^{2-} [(4e for C) + (6e for O) + 2 x (6e for S) + 2 x (1e for – charges)]= 24e

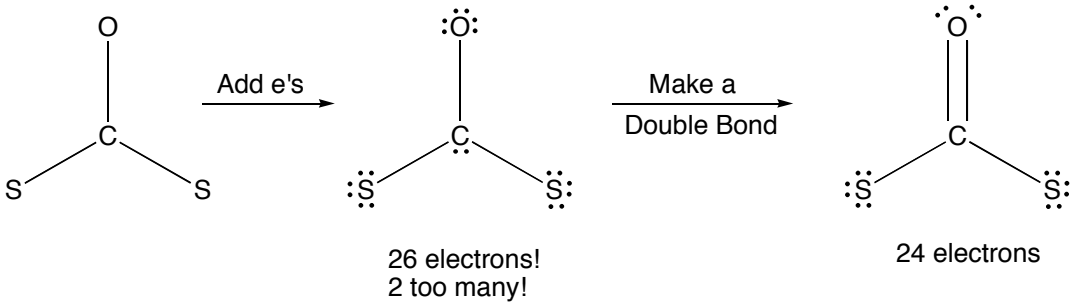
2) Decide which atom is the central atom. This is often the atom with the highest valance (number of attachment points).

a) Write down the central atom and use a line, which represents two electrons, to attach other atoms. Remember not all atoms may be bonded to the central atom.

b) Where possible add enough bonds to the central atom to create an octet around it.

c) Add electrons around each atom to fill its valence shell

d) If there are too many electrons, erase two adjacent lone pairs and make a double bond



At this point, the correct number of valence electrons has been used, and atoms in the structure all have filled valance shells. Furthermore, we have not violated the octet rule; however, the structure above is still not correct—Where are the charges?

3) Calculate the formal charge of each atom:

Formal Charge on an atom = (valence electrons of the atom) – (the number of nonbonding electrons) – $\frac{1}{2}$(the number of bonding electrons)

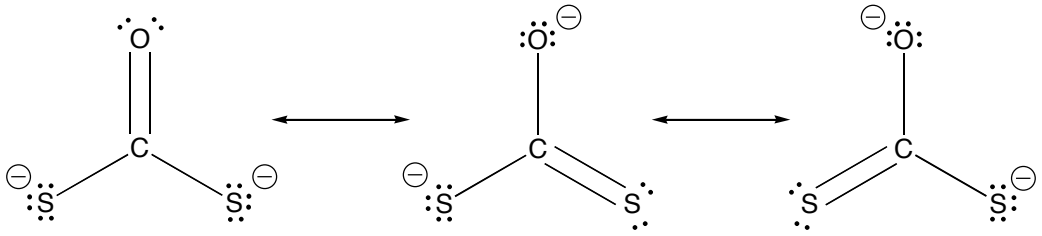
Formal charge on carbon in the above 24 electron structure = 4 – 0 – $\frac{1}{2}$(8) = 0

Formal charge on sulfur in the above 24 electron structure = 6 – 6 – $\frac{1}{2}$(2) = –1

Therefore, each of the sulfur atoms is negatively charged in the Lewis structure (see below).

The charges must always, Always, ALWAYS be drawn!

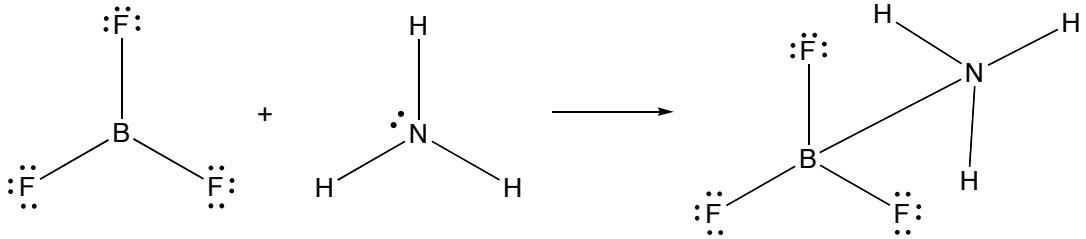
4) Draw the resonance structures. **READ Klein Sections 2.7–2.12.** In the above example, we made a double bond between the carbon and the oxygen, we could have also made the double bond between the carbon and a sulfur atom to make another correct Lewis structure. Use curly arrows to "move" the electrons: **2 arrows on a negatively charged structure and 1 on a positively charged structure.**



Resonance structures are fundamental concepts of organic chemistry. **Draw Lewis structures (and resonance structures where appropriate) for:** CO_3H^-, C_2H_6, C_2H_2, C_3H_6, and CH_4O_2. Because there maybe more than one correct answer in these exercises, once you have a valid Lewis structure and you have drawn the appropriate resonance structure(s) you are done.

5) Using valence shell expansion: Atoms in periods 3 and higher have d orbitals (namely Si, S, P, Cl, Br, and I). Therefore, they can, if needed, have more than 8 electrons in their valance shell. Draw resonance structures for SO_3^{2-}, PCl_5, ClO_4^{1-}

6) Valence shells of B and Al: These atoms each have 3 electrons in their valance shells. Therefore, BCl_3 is a neutral compound and boron does not have an octet of electrons around it. Therefore, BCl_3 is a Lewis acid. Therefore, when Lewis acidic BF_3 and Lewis Basic NH_3 (ammonia) are mixed, a neutral complex forms, but there are formal charges on the boron and the nitrogen atoms. What are the charges?



For Neutral organic compounds where each atoms formal charge is zero,

C, Si……..	4 bonds
N, B, Al……	3 bonds
O……	2 bonds
F, Cl, Br, I, H……	1 bond
S……	2,4,6 bonds (CH_3SH, CH_3SOCH_3 H_2SO_4)
P……	3,5 bonds (PCl_3, PCl_5)