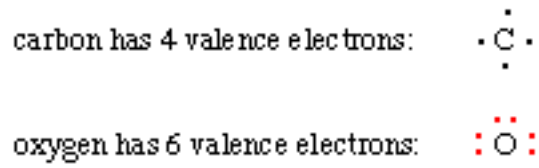
A Brief Tutorial on Drawing Lewis Dot Structures

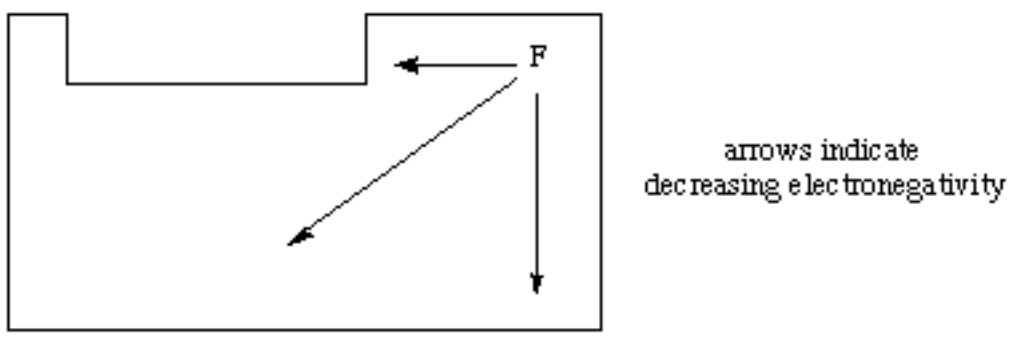
We will use three molecules (CO_2, CO_3^{2-} and NH_4^+) as our examples on this guided tour of a simple method for drawing Lewis dot structures. While this algorithm may not work in all cases, it should be adequate the vast majority of the time.

Procedure for Neutral Molecules (CO_2)

1. Decide how many valence (outer shell) electrons are posessed by each atom in the molecule.

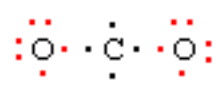


2. If there is more than one atom type in the molecule, put the most metallic or least electronegative atom in the center. Recall that electronegativity decreases as atom moves further away from fluorine on the periodic chart.

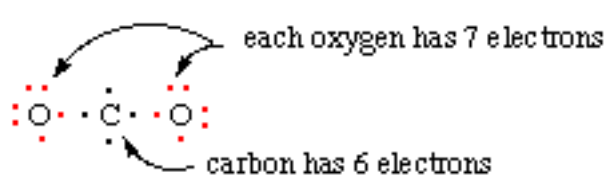


Arrangement of atoms in CO_2: O C O

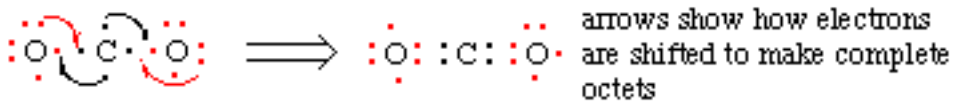
3. Arrange the electrons so that each atom contributes one electron to a single bond between each atom.



4. Count the electrons around each atom: are the octets complete? If so, your Lewis dot structure is complete.

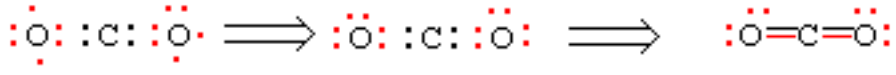


5. If the octets are incomplete, and more electrons remain to be shared, move one electron per bond per atom to make another bond. Note that in some structures there will be open octets (example: the B of BF_3), or atoms which have ten electrons (example: the S of SF_5).



6. Repeat steps 4 and 5 as needed until all octets are full.

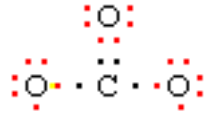
7. Redraw the dots so that electrons on any given atom are in pairs wherever possible.



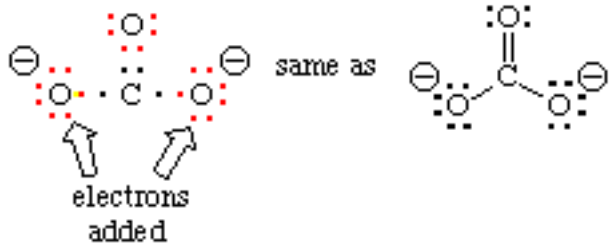
Procedure for Negatively Charged Ions (CO_3^{2-})

Use the same procedure as outlined above, then as a last step add one electron per negative charge to fill octets. Carbonate ion has a 2- charge, so we have two electrons available to fill octets.

Using the procedure above, we arrive a this structure:



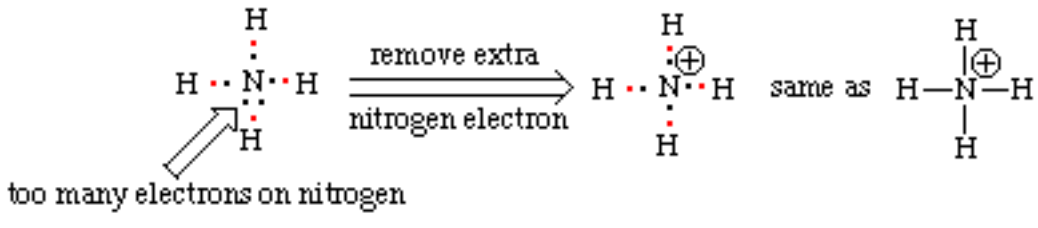
The two singly-bonded oxygen atoms each have an open octet, so we add one electron to each so as to fill these octets. The added electrons are shown with arrows. Don't forget to assign formal charges as well! The final Lewis structure for carbonate ion is:



Procedure for Positively Charged Ions (NH_4^+)

Use the same procedure as outlined above, then remove one electron per postive charge as needed to avoid expanded octets. When using this procedure for positively charged ions, it may be necessary to have some atoms with expanded octets (nitrogen in this example). For each unit of positive charge on the ion remove on electron from these exapnded octets. If done correctly, your final structure should have no first or second period elements with expanded octets.

Using the basic procedure outlined above, we arrive at a structure in which nitrogen has nine valence electrons. (Electrons supplied by hydrogen are red; electrons supplied by nitrogen are black.) Removal of one of these valence electrons to account for the 1+ charge of ammonium ion solves this octet rule violation.



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