STEPS FOR DRAWING LEWIS STRUCTURES

Lewis structures are formulas in which atomic symbols represent nuclei and inner shell electrons, dot-pairs or dashes between two atom symbols represent electrons in covalent bonds, and dots adjacent to just one atom symbol represent unshared electrons. The OCTET RULE essentially states that every atom wants 8 electrons around it, except for hydrogen which can only fit 2.

SINGLE BONDS

1. **Determine the number of atoms present in each molecule**
   a. H_2O has 2 hydrogen atoms and 1 oxygen atom
2. **Write the electron dot notation for each type of atom (figure out the number of valence electrons and put that many dots around the symbol with two on each side)**
   a. H O H
3. **Determine total number of valence electrons in the atoms that are bonding, taking into account how many of each atom you have.**
   a. H_2O

H	2 atom x 1 electron =	2 e-
O	1 atom x 6 electrons =	6 e-
	Total	8 e-

   NOTE: If you are drawing a Lewis structure for a polyatomic ion, it is in this step that you would add or take away electrons from your TOTAL (i.e. so if a polyatomic ion has a charge of +2, you would SUBTRACT 2 electrons from your total. If the charge is -2, you would ADD 2 electrons to your total and go from there…)

4. **Arrange the atoms to form a "skeleton structure" for the molecule and connect the atoms by electron pair bonds (two electrons between each atom symbol). *Always put the more electronegative atom in the middle. If carbon is part of your compound, it ALWAYS goes in the middle. Otherwise, it should be pretty obvious which one goes in the middle (the "single" atom). You only have one O, so it will go in the middle.***
   a.
   H O H
5. **Count up how many electrons have been used and how many you have left over.**
   a. Example
   H O H
   - Used 4 electrons (2 between each H and the O)
   - Have 4 left over
6. **Distribute the remaining electrons, in pairs, around appropriate atom. The goal is for every atom to have 8 electrons around it (to look like a noble gas!!)**
   a. Example H O H

7. **Replace electron pairs between atom symbols with a dash to represent a shared electron pair.**
    a. H O H
8. **Count up the electrons around each atom to make sure each one has 8 (remember the dash equals 2 electrons and H only needs 2 electrons to be full)**
    a. Each H has 2 electrons and the oxygen is sharing 4 electrons with the H's and has 4 of its own (8 total).

Here are a few exceptions to the rule:

- Boron is a special element and can have an incomplete octet—needing only 6 electrons.
- Some elements, such as F, O, Cl, or P can have "expanded octets" accepting more than 8 electrons by using d-orbital electrons due to their high electronegativity.

Draw the Lewis structure for PF_3

STEP 1

STEP 2

STEP 3

STEP 4

STEP 5

STEP 6

STEP 7

STEP 8

Once you have practiced a few times, you won't necessarily have to do every little step…

MULTIPLE BONDS

1. **Determine the number of atoms present in each molecule**

   CO_2

2. **Write the electron dot notation for each type of atom (figure out the number of valence electrons and put that many dots around the symbol with two on each side)**
   a. O C O
3. **Determine total number of valence electrons in the atoms that are bonding, taking into account how many of each atom you have.**
   a. CO_2

C	1 atom x 4 electron =	4 e-
O	2 atom x 6 electrons =	12 e-
	Total	16 e-

      NOTE: If you are drawing a Lewis structure for a polyatomic ion, it is in this step that you would add or take away electrons from your TOTAL (i.e. so if a polyatomic ion has a charge of +2, you would SUBTRACT 2 electrons from your total. If the charge is -2, you would ADD 2 electrons to your total and go from there…
4. **Arrange the atoms to form a "skeleton structure" for the molecule and connect the atoms with electron bond pairs (two electrons between each atom symbol).** ***Always put the more electronegative atom in the middle. If carbon is part of your compound, it ALWAYS goes in the middle. You have carbon in this compound, so it goes in the middle.***
   a.

      O C O
5. **Count up how many electrons have been used and how many you have left over.**
   a. Example

      O C O

      - Used 4 electrons (2 between each C and the O)
      - Have 12 left over
6. **Distribute the remaining electrons, in pairs, around appropriate atom. The goal is for every atom to have 8 electrons around it (to look like a noble gas!!) Start with the atoms on the OUTSIDE, then if there are any left over, put them on the inner atom.**
   a. Put lone pairs (unshared electrons) around each oxygen so that they have a full octet (now you've used all your electrons)

      O C O
7. **Replace electron pairs between atom symbols with a dash to represent a shared electron pair.**
8. **Count up the electrons around each atom to make sure each one has 8 (remember the dash = 2 electrons and H only needs 2 electrons to be full). Both oxygen are happy, but carbon is miserable. So, move a lone pair from each O to C, making 2 double bonds to C. remember that shared pairs count for both atoms!**

Draw the Lewis structure for nitrogen gas, N_2

STEP 1

STEP 2

STEP 3

STEP 4

STEP 5

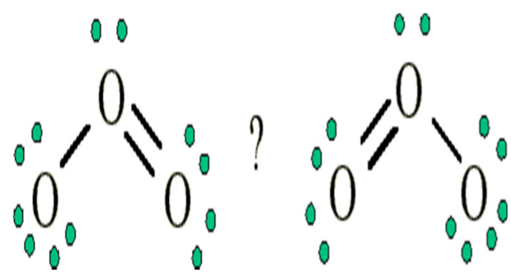
STEP 6

STEP 7

STEP 8

Draw the Lewis structure for ozone, O_3. Try and combine the steps at this point, if you can…

You should end up with a Lewis structure that has a single bond on one side and a double bond on the other. Question! Is there a "correct" side of the molecule that should have the single bond while the other should have the double? NO! It doesn't matter. **This brings us to RESONANCE STRUCTURES. To accurately represent the Lewis structure, you need to draw all possible locations for the double bond (i.e. resonance structures).** Experimental evidence shows that there is not a mixture of single and double bonds, but that all of the bonds are identical, so there is an average of the structures. We show all possible structures, using a double-headed arrow.



Draw the Lewis structure for ammonium $[NH_4]^{+1}$. See the note under STEP 3 in the instructions to figure out what to do with the charge!!!