Chemistry Lecture #39: Lewis Dot Structures

Lewis dot structures are diagrams that show how atoms in a molecule are bonded together. Simple Lewis dot structures can be made by following the following steps:

1. Draw a dot diagram of each atom in the molecule.
2. Determine how many unpaired electrons are on each atom - this is the number of bonds it will form.
3. Arrange the atoms so that an unpaired electron can pair up with another unpaired electron.
4. If you wish, draw a line to substitute for a pair of shared electrons.
5. check your work. Is each atom making the correct number of bonds? Does hydrogen now have two electrons, and do the other atoms have eight?

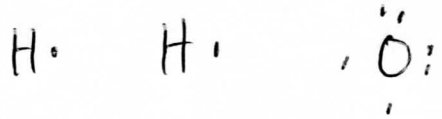
Draw the Lewis structure for H_2.

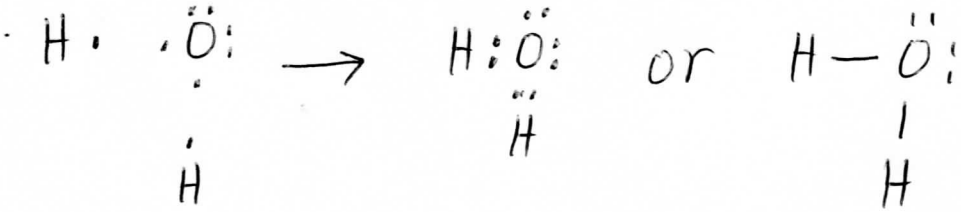
H• •H

H:H or H–H

Notice that each hydrogen forms one bond.

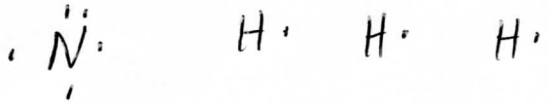
Draw the Lewis structure for H_2O.

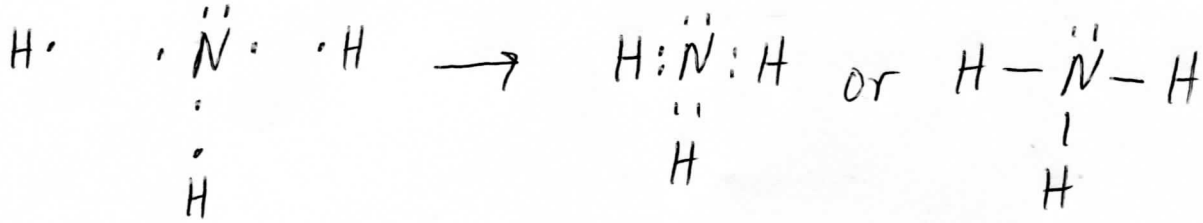




Notice that each hydrogen forms one bond. Oxygen forms two bonds since it starts with two unpaired electrons.

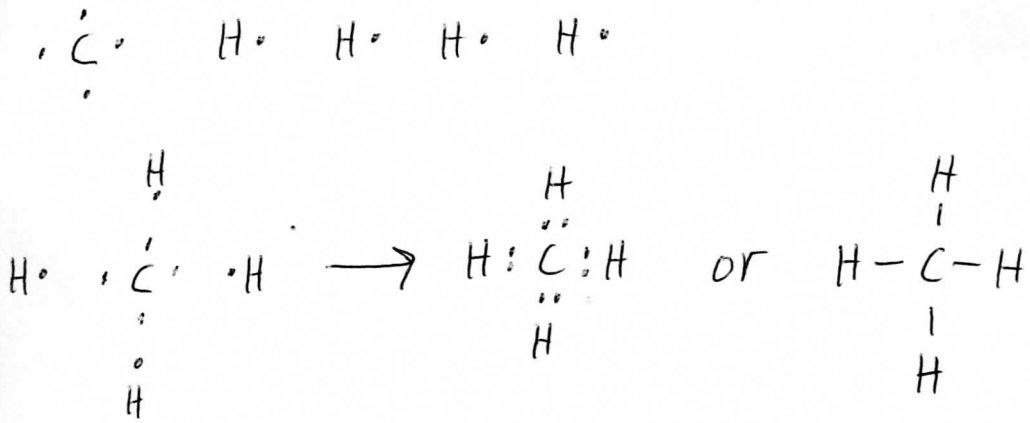
Draw NH_3





Notice that nitrogen starts with 3 unshared electrons, and forms 3 bonds.

Draw CH_4



Notice that carbon starts with 4 unshared of electrons, and forms 4 bonds.

This procedure works with simple molecules. But it is helpful to use another procedure when the molecules become more complicated.

The following procedure works for both simple and complicated molecules.

1. Draw a dot diagram of each atom to determine the number of unpaired electrons on each atom. This will be the number of bonds it can form.

2. Estimate the location of the atoms. The atom with the most unpaired electrons will probably be in the middle, and the other atoms will surround and bond with it.

3. Count the total number of valence electrons from all of the atoms.

4. Place pairs of electrons between the central atom and the surrounding or terminal atoms. Keep track of the number of pairs distributed.

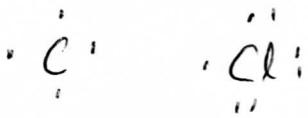
5. Place the remaining electrons in pairs on the terminal atom until each has an octet. But do not put extra electrons on hydrogen (it only wants 2 electrons).

6. If there are any electrons still left over, place them on the central atom.

7. If the central atom does not have an octet, move pairs of unshared electrons from the terminal atoms so they are between the central atom and the terminal atom.

Draw the Lewis structure for CCl_4.

The dot structures for C and Cl are



We see that C can form 4 bonds and each Cl can form one bond. C is likely to be the central atom.

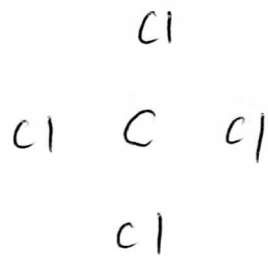
The total number of valence electrons is

C: 1 x 4 = 4

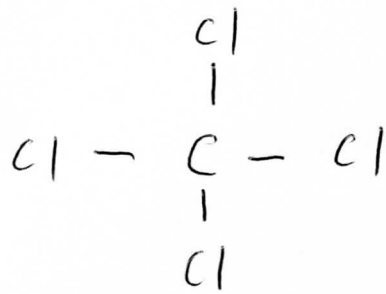
Cl: 4 x 7 = 28

Total # = 32

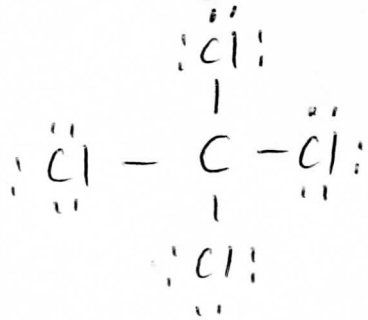
Drawing the basic structure



Adding pairs of electrons between the C and Cl's



8 electrons have been used up. If we distribute pairs of electrons to the Cl's we get



This uses up all the valence electrons. Each chlorine forms one bond, carbon forms 4 bonds, and everyone has an octet. Everyone is now happy.

Draw the Lewis structure for PH_3.

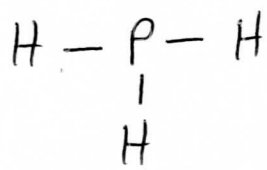
P can form 3 bonds, H can form one bond.

P: 1 x 5 = 5

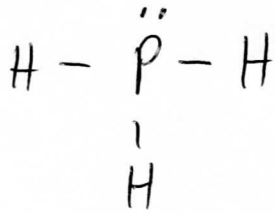
H: 3 x 1 = 3

Total of 8 valence electrons.

With P in the center, we can distribute 6 electrons.

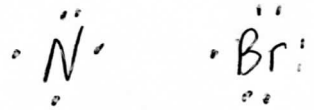


We have two electrons left over. Do we put them on a hydrogen? Nope! Hydrogen only wants 2 electrons. Put the electrons on the P.



P is forming 3 bonds, the H's are each forming one bond. P has an octet and each H has 2 electrons. Everyone is happy.

Draw the Lewis structure for NBr_3



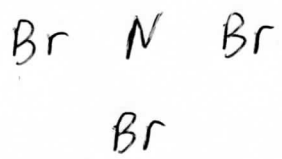
N can form 3 bonds, and each Br can form one bond.

N: 1 X 5 = 5

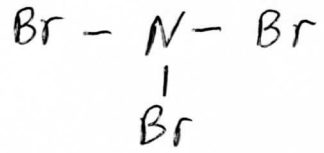
Br: 3 x 7 = 21

Total of 26 valence electrons.

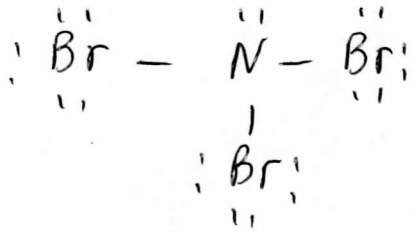
The basic structure is



Adding electrons between N and the Br's uses 6 electrons.



Distributing the electrons to the Br's uses 18 electrons for a total of 24. The remaining 2 electrons are placed on the N.



Draw the Lewis structure for CO_2

Carbon can form 4 bonds, and each oxygen can form 2 bonds.

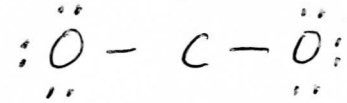
C: 1 x 4 = 4

O: 2 x 6 = 12

Total of 16 valence electrons.

We put carbon in the middle and oxygen at each end, then distribute electrons between the atoms.

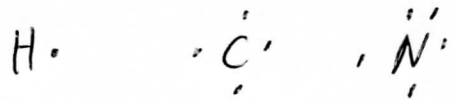
This uses up 4 electrons with 12 left over. We put electrons around the oxygens.



This uses up all the electrons. But carbon only has 4 electrons. So we move an unshared pair of electrons from each oxygen and put them in between the carbon and oxygen to make double bonds.

Carbon forms 4 bonds, each oxygen forms 2 bonds, and everyone has an octet.

Draw HCN



Hydrogen can form one bond, carbon can form 4 bonds, and nitrogen can form 3 bonds. Carbon will be in the middle.

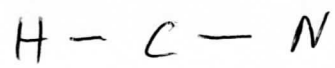
H: 1 x 1 = 1

C: 1 x 4 = 4

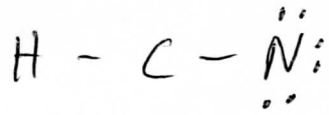
N: 1 x 5 = 5

Total of 10 valence electrons.

We put carbon in the middle and hydrogen and nitrogen at each end. We put electrons in between the atoms.



This uses up 4 electrons. We put the remaining 6 around nitrogen.



Carbon only has 4 electrons. So we move two pairs of electrons from nitrogen and put them between the nitrogen and the carbon. This forms a triple bond.

C and N have an octet, H has a pair of electrons, and everyone makes the appropriate number of bonds.