

LEWIS STRUCTURES

1. Count # of valence e's.

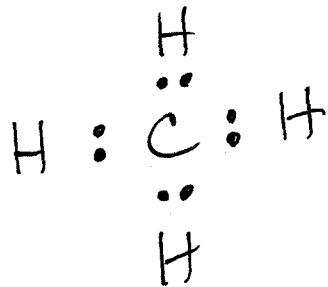


$$\left. \begin{array}{l} \text{C: } 4 \\ \text{H: } 1 \times 4 \end{array} \right\} = 8 \text{ v.e.}$$

a. add one for each \ominus charge

b. subtract one for each \oplus charge

2. Arrange the atoms. Generally put carbon on "inside" (forms 4 bonds)
put H on "outside" (forms one bond)



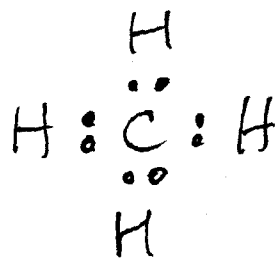
3. Fill in e's so everyone has noble gas config. (Fill the octets.)

Recall: octet rule says that all 1st row elements (H is the exception) cannot have more than 8 e's around them. (H can only have 2).

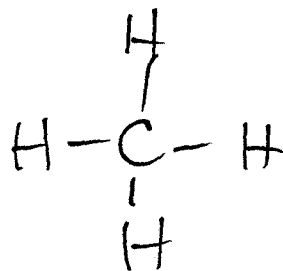
Exceptions: (Boron is neutral w/ 6 e's
Beryllium is neutral w/ 4 e's)

Classic Lewis structure uses all dots.

We use modified version - a dash is a bond and has 2e'; still use dots for unshared e's.

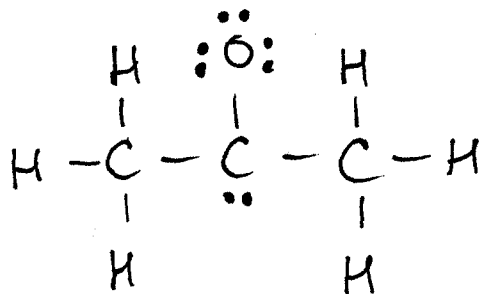


becomes



C_3H_6O ① Count v.e.

$$(4 \times 3) + (1 \times 6) + 6 = 24 \text{ v.e.}$$

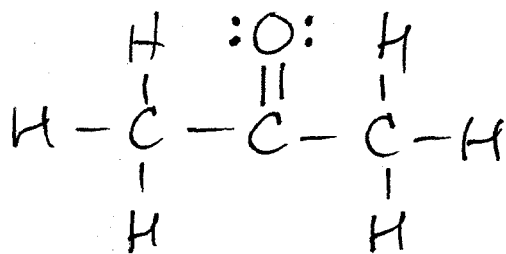


② Fill octets

③ check e⁻ count.

26 v.e. - TOO MANY!

④ Too many? Remove unshared pairs from adjacent atoms + replace w/ a 2nd covalent bond.



⑤ check e⁻ count again
24 v.e.

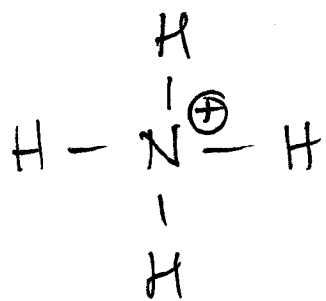
OK

useful Information - Neutral arrangements

- | | | |
|---------------------------|----|---|
| $\frac{\text{v.e.'s}}{1}$ | 1. | H only forms <u>one</u> bond. |
| 4 | 2. | C prefers to form 4 covalent bonds. |
| 5 | 3. | N prefers to form 3 covalent bonds (usually has 1 lone pair) |
| 6 | 4. | O prefers to form 2 covalent bonds (2 lone pairs) |
| 7 | 5. | X (halogens) prefer to form 1 covalent bond (3 lone pairs) |

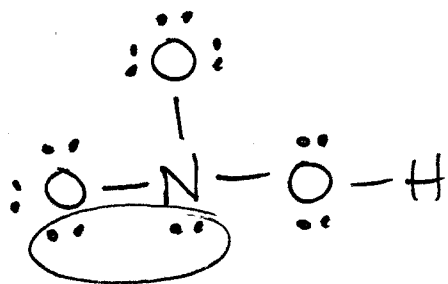
Best Lewis structures have no formal charges. (or, formal charges are minimized)

$$\text{F.C. on an atom} = \# \text{v.e.'s} - \# \text{covalent bonds} - \# \text{unshared e's.}$$

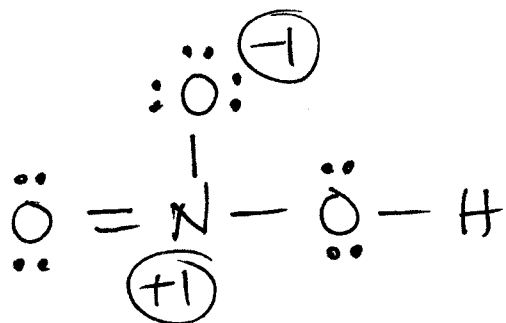


$$\begin{aligned} \text{F.C.} &= 5 \text{ v.e.} - 4 \text{ bonds} - \emptyset \text{ unshared e's} \\ &= +1 \end{aligned}$$

Nitric Acid: HNO_3 24 v.e.



26 v.e. TOO MANY



24 v.e. OK

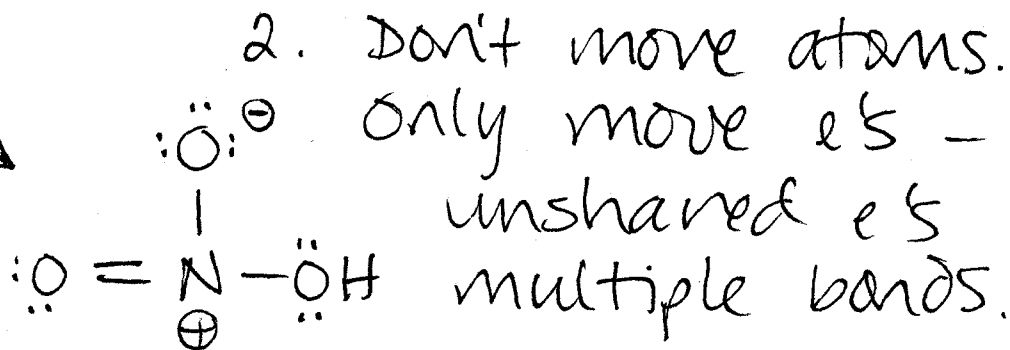
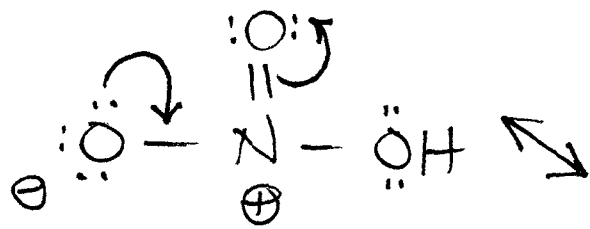
If you can't avoid formal charges:

- try to keep them at \oplus \ominus (avoid $\oplus 2$)
- try to get the \ominus charge on the more e⁻ req atom. ($\ominus 3$ etc.)
- keep charges as close together as possible

Biggest problem w/ Lewis structures - force e's to be localized. In reality, e's distribute themselves so as to achieve the most stable arrangement - this often means that some or all of the e's are delocalized.

We explain/illustrate this concept of delocalization using resonance theory.

1. Resonance structures only exist on paper - reality is a hybrid.



1. Resonance structures only exist on paper! Reality is a hybrid. The more stable a Lewis structure is in and of itself, the greater its contribution to that reality.
2. You can't move the atoms, only the electrons. (Corollary - only move electrons in multiple bonds or lone pairs, leave the single bonds alone.)
3. Don't violate the octet rule! All resonance structures must be proper Lewis structures.
4. A few comments on stability:
 - a. The more covalent bonds a structure has, the more stable it is.
 - b. Structures with complete octets are more stable than structures that do not have complete octets on all atoms.
 - c. When there is more than one possible structure that satisfies the octet rule, the "best" Lewis structure (and hence the one that contributes most to the overall "real" picture of the molecule or ion) is the one that has the smallest separation of oppositely charged atoms. Charge separation destabilizes molecules.
 - d. Given a choice, the "best" Lewis structure is that one where the negative charge is on the more electronegative atom (and the positive charge is on the less electronegative atom).
5. Each contributing Lewis structure must have the same number of electrons and the same overall charge (although formal charges can vary).
6. Each structure must have the same number of unpaired electrons.
7. Electron delocalization stabilizes a molecule. The true picture of the molecule is a combination of all "good" Lewis structures for that molecule, and the energy of that molecule is lower than might be predicted for the individual resonance structures.