

Chem 101A – Drawing Lewis Dot Structures and Formal Charge

Drawing Lewis structures is easy, if you follow the steps. Some things to consider are:

- Octet structures – With elements in the first two rows of the periodic table, use the octet rule.
 - Advanced structures – atoms of elements below the second row of the periodic table can have more than 8 electrons around them. They may contain more than 4 bonds (8 electrons). Use formal charge rules to predict the best structure.
 - Strict Octet – atoms in second row need to have 8 bonding or non-bonding electrons around them. Exceptions: Be, B. **Second-row elements must never exceed 8 electrons!**
 - Octet exceptions:
 - Be (2 bonds) and B (3 bonds)
 - H: one bond –or– one lone pair **only**
 - Resonance structures – draw equivalent structures when asymmetry is present in multiple bonds
1. Count valence electrons contributed from all atoms. For anions, add one electron for each negative charge. For cations, subtract one electron for each charge. Use this number of electrons exactly for bonding and non-bonding in the structure.
 2. Place atoms around a central atom (lone atom, or the atom with the lowest electronegativity).
 3. Place one bond (2 electrons) between each outer atom and the central atom. Subtract from the original electron count.
 4. Place lone pairs (2 unshared electrons—non-bonding electron pairs) on the outer atoms (except H), until each has satisfied the octet or until there are no more remaining. Subtract from the count as you use them.
 5. If there are remaining electrons, place them on the central atom, in pairs. Subtract electrons used.
 6. If the central atom does not meet the octet, then share previously assigned non-bonding electrons from outer atoms to form double and triple bonds.
 - a. If you must choose which outer atoms, then we must describe the structure using additional resonance structures by drawing each contributing resonance structure, each separated by a double-headed arrow..
 7. You may need to use formal charge rules to decide on whether or not to form double/triple bonds, and/or write additional resonance structures (see next page).

Formal Charge

Formal charge (FC) is assigned per atom as a consideration in evaluating structures. Preferred structures should minimize formal charges.

$$\text{FC} = (\text{valence electrons}) - \frac{1}{2} (\text{bonding electrons}) - \text{nonbonding electrons}$$

i.e. $\text{FC} = \text{group \#} - \text{bonds} - \text{dots}$

Note: sum of all formal charges in structure = net charge of the structure

Formal Charge General Rules:

- If a structure has many non-zero formal charges, form double bonds to modify formal charges, redistribute electrons, and/or evaluate octet rule.
- avoid structures with positive charges on high-electronegativity atoms
- avoid structures with negative charges on low-electronegativity atoms