

# Writing Electron Dot Structures

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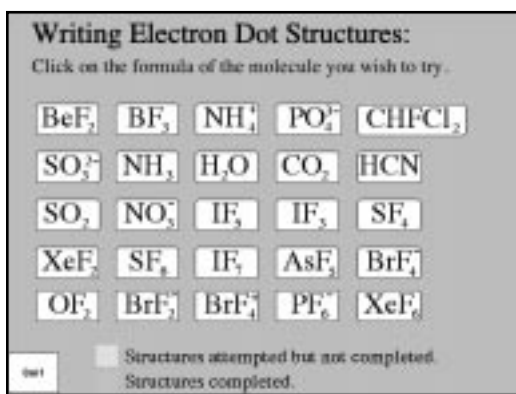
## Abstract

Writing Electron Dot Structures is a computer program for Mac OS that provides drill with feedback for students learning to write electron dot structures. While designed for students in the first year of college general chemistry, it may also be used by high-school chemistry students.

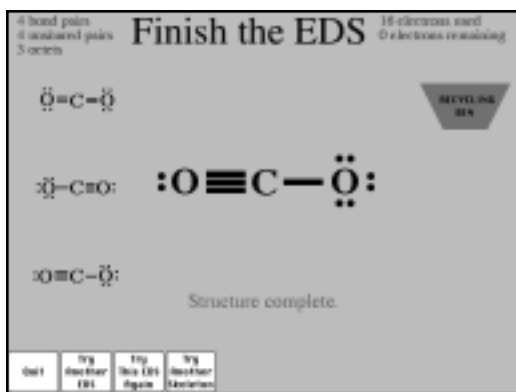
A systematic method similar to that found in many general chemistry texts is employed:

1. determine the number of valence shell electrons,
2. select the central atom,
3. construct a skeleton,
4. add electrons to complete octets,
5. examine the structure for resonance forms.

During the construction of a structure, the student has the option of quitting, selecting another formula, returning to a previous step, or seeking help.



Screens from Writing Electron Dot Structures.



Once a molecule or ion is selected, Writing Electron Dot Structures asks for the number of valence electrons and the identity of the central atom. If an incorrect number of electrons is entered, the student may not proceed until the correct number is entered. The symbol entered for the central atom must follow accepted upper/lower case practice, and entry of the correct symbol must be accomplished before proceeding to the next step. A periodic table is accessible, and feedback provides assistance for these steps.

Construction of the skeleton begins with the placement of the central atom. Atoms can be added, moved, or removed. Prompts and feedback keep the student informed of his or her progress and problems. A correct skeleton is required before proceeding to the next step.

Completion of the structure begins with the addition of electron pairs to form the required bonds. Remaining electrons are added to complete the formation of multiple bonds, comply with the octet rule, and form expanded octets. Resonance forms are made by moving or removing and replacing electron pairs in the existing skeleton. Prompts and feedback guide the student through this process. A running tally of bond pairs, unshared pairs, octets, electrons used, and electrons remaining is provided during this step.

## Steps for Electron Dot Structures

Use the following steps to write the electron dot structure of a molecule or a polyatomic ion.

1. Write the formula of the molecule or ion.
2. Count the electrons available: the total number of valence shell electrons. Each atom in the molecule or ion contributes the electrons in the outermost s and p orbitals. Remember that *all* of these must appear in the final structure.
3. Draw the skeleton. This is the central atom(s) with all of the outer atoms arranged around it (them).
4. If not indicated, the central atom is an atom of the element which:
  - is not H or F.
  - is not O, Cl, Br, or I unless the only other atoms are H, O, or halogens.
  - is least numerous in the molecule or ion.
  - is the largest in the molecule or ion (usually furthest toward the lower left side of the periodic table).
  - has the highest bonding capacity (again, usually furthest toward the lower left side of the periodic table).
5. Add enough bonds (pairs of electrons) to hold the molecule or ion together. Limit bonds to one pair of electrons per pair of bonded atoms. A bond should be between a central atom and an outer atom or between two central atoms, but not between two outer atoms.
6. Some atoms now will have complete octets (surrounded by four pairs of electrons). Use the remaining electrons (you must use all of those counted in Step 2) to complete octets surrounding the remaining atoms. It is usually best to add unbonded electron pairs to all of the outer atoms before adding any to the central atom(s).
7. Carefully check your count of electrons. If all atoms in the structure (with the exception of H, Li, Be, or B) are surrounded by octets, the structure is complete. If not, complete it by using one of the following:
  - a. If some octets are incomplete and all of the electrons have been used, rearrange the electron pairs so that some pairs of atoms are joined with more than one pair of electrons—multiple (double or triple) bonds. This is usually accomplished by moving unshared pairs on the outer atoms into a bonding position. Do not make multiple bonds with either H or F.
  - b. If all of the atoms are surrounded by an octet and electrons are left over, add the remaining electrons to the central atom. This will result in a central atom with more than eight electrons—a situation called an “expanded octet”. Note that expanded octets do not occur when the central atom is C, N, or O.

If it is not possible to satisfy the conditions in Step 7, check your count of valence electrons in Step 2. If your count was correct, consult your instructor.

## **Instructor Notes**

Many introductory chemistry students have difficulty learning to produce electron dot structures. *Writing Electron Dot Structures* provides students with immediate feedback while they practice on a variety of molecules and polyatomic ions. The interface is simple with complete on-screen instructions so that the students can focus on electron dot structures, not on learning to use the software.

This program does not address molecular geometry.

The “Steps for Electron Dot Structures” on the preceding page can be duplicated and handed to students as a general guide when using the program, or for writing electron dot structures in general.