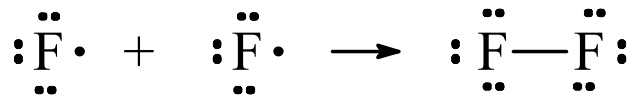
**Lewis Model of Covalent Bonding**
**(G. N. Lewis & Irving Langmuir - 1916)**

L A chemical bond is formed when one or more pairs of electrons are shared between two atoms in such a way that each achieves the equivalent of a noble gas configuration.

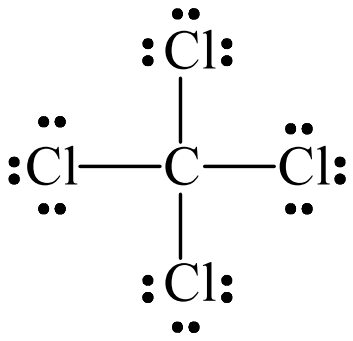
$$H\cdot + H\cdot \rightarrow H{:}H \rightarrow H\text{–}H$$

Each H has a net of 2 electrons through sharing.

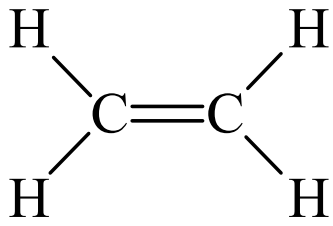


Each F has a net of 8 electrons through sharing.

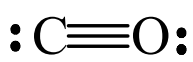
# Single-, Double-, and Triple-Bonds




C-Cl single bonds




C=C double bond




C / O triple bond

## Bond Order, Bond Length, and Bond Strength

- As bond order increases between a pair of atoms, bond length *decreases* and bond strength *increases*.

| Compound | $d_{C\text{-}C}$ | $D_{C\text{-}C}$ |
|---|---|---|
| $H_3C–CH_3$ | 1.54 Å | 368 kJ/mol |
| $H_2C=CH_2$ | 1.34 Å | 435 kJ/mol |
| HC / CH | 1.20 Å | 962 kJ/mol |

# Steps for Drawing Electron Dot Models

1. Arrange the atoms of the compound or complex ion so as to show how they are linked together by chemical bonds. When in doubt, assume that the *least electronegative* atom is central.

2. Count the valence electrons for each atom. For non-transition elements, the number of valence electrons is the same as the group number of the element. For a complex anion, add electrons equal to the negative charge. For a complex cation, subtract electrons equal to the positive charge. The total is the number of electrons to be used in generating the model.

3. Draw in single bonds (–) between all atoms that are linked together, keeping in mind that each bond represents the use of two electrons from the total established in step 2.

4. With the remaining electrons, first add pairs (:) to all of the outer atoms to make octets (except H), then add any leftover electrons to the central atom. The octet for each atom includes pairs used to make bonds in step 3.

5. Leave no electrons unpaired unless the total number of electrons is odd.

6. Count the number of electrons about the central atom to see if an octet has been made there. If not, try moving non-bonding pairs (:) from outer atoms to make double or triple bonds to the central atom. However, note that
   (a) hydrogen and the halogens do not form multiple bonds, and
   (b) elements in the third and higher periods usually do not form effective multiple bonds.

7. If there are too few electrons to give octets to all atoms (except hydrogen), the central atom *might* be electron deficient, particularly if it is Be, B, or Al. Examples: $BeH_2$, $BCl_3$, $AlCl_3$. However,
   (a) outer atoms are *never* electron deficient, and
   (b) C, N, O, and F *almost always have an octet*.

8. Sometimes central atoms from the *third and higher periods* have more than an octet (*hypervalence*), but only when necessary. Examples: $PCl_5$, $XeF_2$, $XeF_4$. However,
   (a) outer atoms are *never hypervalent*, and
   (b) C, N, O, and F are *never hypervalent*.

9. The representation of any anion or cation should be surrounded by square brackets ([ ]) with the charge indicated on the outside as a superscript.

10. Count up the number of electrons in the completed model to be sure it is the same as the total established in step 2.