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Lewis Dot Structures

- A Lewis dot structure is a visual representation of the bonding between atoms in a molecule. It also shows any lone pairs of electrons that may exist on atoms.
- **How to Draw a Lewis Dot Structure:**
    - **1. Determine the Central Atom**
        - Place the least electronegative atom in the center (never hydrogen, it always goes on the outside because it forms only one bond).
    - **2. Count Total Valence Electrons:**
        - Use the periodic table to determine how many valence electrons each atom contributes. Add the up for the whole molecule
            - Group 1 has 1 valence electron
            - Group 4 has 4 valence electrons
            - Group 5 has 5 valence electrons
            - Group 6 has 6 valence electrons
            - Group 7 has 7 valence electrons
        - Group-based bonding patterns (for typical main group elements) are as follows:
            - Group 1 (e.g., H): 1 bond, no lone pairs

            - Group 4 (e.g., C): 4 bonds, no lone pairs

            - Group 5 (e.g., N): 3 bonds, 1 lone pair

            - Group 6 (e.g., O): 2 bonds, 2 lone pairs

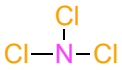
            

            - Group 7 (e.g., F): 1 bonds, 3 lone pairs

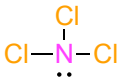
            

    - **3. Draw Bonds and Fulfill the Octet Rule**
        - Use single, double, or triple bonds as needed to connect atoms and ensure most atoms (except hydrogen) are surrounded by 8 electrons
        - Place any remaining electrons as lone pairs on outer atoms first, then on the central atom if needed

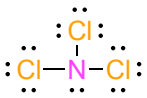
- **Example 1:** NCl_3
  1. **Determine the Central Atom**
     - Nitrogen is the central atom because it is less electronegative than chlorine
  2. **Count Total Valence Electrons**
     - Nitrogen = 5 valence electrons
     - Chlorine = 7 valence electron x 3 = 21
     - Total = 5 + 21 = 26 valence electrons
  3. **Draw the Initial Bonds**
     - Connect each chlorine atom to nitrogen with a single bond (3 bonds x 2 electrons = 6 electrons used)



  4. **Complete the Octet**
     - Nitrogen has 6 electrons from the three bonds, so it needs 1 lone pair (2 electrons) to reach an octet → now nitrogen has 8 electrons.
     - Each chlorine has 2 electrons from the bond, and needs 6 more → add 3 lone pairs (6 electrons) to each Cl atom



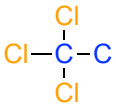
  5. **Check Total Electrons**
     - Bonds = 3 x 2 = 6 electrons
     - Nitrogen lone pair = 2 electrons
     - Chlorine lone pairs = 3 Cl x 3 lone pairs x 2 electrons = 18 electrons
     - Total = 6 + 2 + 18 = 26 electrons, which matches the valence electrons

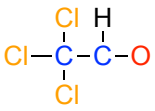


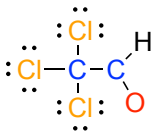
Example 2: CCl_3CHO

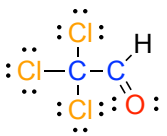
1. **Determine the Central Atom**
   - Carbon atoms go in the middle because they are the least electronegative and they will form the backbone
   - One carbon is bonded to three Cl atoms, and the other is bonded to an O and an H
2. **Count the Total Valence Electrons**
   - Carbon = 4 valence electrons x 2 = 8
   - Chlorine = 7 valence electrons x = 21
   - Hydrogen = 1 valence electron = 1
   - Oxygen = 6 valence electron = 6
   - Total = 8 + 21 + 1 + 6 = 36 valence electrons
3. **Draw the Initial Bond**
   - Connect the two carbon atoms with a single bond

     
   - Connect 3 Cl atoms to the first carbon

     
   - Attach H and O to the second carbon

     
4. **Complete the Octet**
   - Let's give every atom the electrons they need:
   - Each Cl gets 3 lone pairs (6 electrons): 3 x 6 = 18 electrons

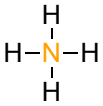
     
   - Oxygen needs 6 more electrons. Because group 6 elements generally like 2 bonds and 2 lone pairs, we will add a double bond between the oxygen and carbon and 2 lone pairs

     
5. **Check the Total Electrons**
   - C-Cl bonds x 3 = 6 electrons, C-C bond = 2 electrons, C=O bond = 4 electrons, C-H bond = 2 electrons
   - Cl lone pairs = 6 x 3 = 18 electrons, O lone pairs = 4 electrons
   - Total: 6 + 2 + 4 + 2 + 18 + 4 = 36 electrons ✅

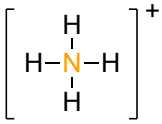
Example 3: Charged Molecule, NH_4^+

- If molecule or ion is negatively charged:
  - Add electrons to your total valence electron count
  - Example: For a $^{3-}$ charge, add 3 extra electrons
- If molecule or ion is positively charged:
  - Subtract electrons from your total valence electron count
  - Example: For a $^{2+}$ charge, remove 2 electrons

1. **Determine the Central Atom**
   - Nitrogen is the central atom because hydrogen can only form one bond each
2. **Count Total Valence Electrons**
   - Nitrogen = 5 valence electrons
   - Hydrogen = 1 valence electron x 4 = 4 valence electrons
   - Subtract 1 electron for the $^{+1}$ charge
   - Total = 5 + 4 - 1 = 8 valence electrons
3. **Draw the Initial Bonds**
   - Connect each hydrogen to nitrogen using a single bond (4 bonds x 2 electrons = 8 electrons used)



4. **Complete the Octet**
   - Nitrogen has 4 bonds = 8 electrons around it → octet is satisified
   - Hydrogen atoms are happy with just 1 bond each → also satisfied
   - All 8 electrons are used in bonds, and no lone pairs are needed
5. **Check Total Electrons**
   - Bonds = 4 x 2 = 8 electrons
   - No lone pairs in this structure
   - Total = 8 electrons, which matches our valence count
   - Because this is an ion, we must put the final Lewis structure in brackets and indicate the $^+$ charge



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Practice

- Draw the Lewis Dot Structures for the following molecules:
  a. NO_3^-

  b. CH_3NH_2

  c. F_2

  d. CO_2

  e. $HCCl_3$

  f. H_3O^+