

Essential Question

How do we draw the electrons in a molecule?

Valence Electrons

- Valence electrons are the outermost s and p electrons, the ones that take part in bonding.
- They are the only electrons shown in a Lewis diagram. Core electrons are left out.

For main group elements, the group number gives the count.

Lewis Symbols for Atoms

- The element symbol stands for the nucleus plus the core electrons.
- Each dot is one valence electron.
- Place one dot on each of the four sides before pairing them up.

Pairing starts with
nitrogen's fifth electron.

Bonding Pairs and Lone Pairs

- **Bonding pair:** a pair of electrons shared by two atoms. It holds the atoms together.
- **Lone pair:** a pair that belongs to just one atom (also called a nonbonding pair).
- One line = one bonding pair = 2 e^-

Check Cl_2 : 2 (bond) + 6 + 6 (lone pairs) = 14 e^- , which matches $7 \times 2 = 14$.

The Octet Rule

- Most atoms share electrons until they are surrounded by 8 valence electrons, like a noble gas.
- Hydrogen only needs 2 (a duet), so it forms one bond and never has lone pairs.
- Shared electrons count toward the total for both atoms.

In HCl, chlorine has three lone pairs (6 e⁻) plus the bond (2 e⁻) for 8.

Single, Double, and Triple Bonds

- **Single bond:** one shared pair, 2 e^- (H_2)
- **Double bond:** two shared pairs, 4 e^- (O_2)
- **Triple bond:** three shared pairs, 6 e^- (N_2)

No matter how many lines there are, every line counts as 2 electrons.

Steps for Drawing Lewis Diagrams

1. **Count** the total valence electrons.
For an ion, add one electron per negative charge or subtract one per positive charge.
2. **Pick the central atom.** It is usually the least electronegative atom, often the one that appears only once. Hydrogen is never central.

Final check: the electrons in your drawing must equal the total from step 1, and every atom should have an octet (a duet for hydrogen).

Steps for Drawing Lewis Diagrams

3. **Connect** each outer atom to the central atom with a single bond.
Subtract 2 e^- per bond.
4. **Complete the octets** of the outer atoms with lone pairs.
Hydrogen already has its 2.

Steps for Drawing Lewis Diagrams

5. **Place leftover electrons** on the central atom as lone pairs.
6. **Check the central atom.** If it has fewer than 8, move a lone pair from an outer atom into a double bond (or a triple bond if needed).

Polyatomic Ions

- Negative charge: add electrons (one per negative charge).
- Positive charge: subtract electrons (one per positive charge).
- Put the whole diagram in square brackets and write the charge at the top right.

Hydroxide, OH^- , has $6 + 1 + 1 = 8 \text{ e}^-$, where the last 1 comes from the 1^- charge.

Exceptions to the Octet Rule

- **Fewer than 8:** boron commonly has 6 and beryllium commonly has 4.
- **More than 8 (expanded octet):** only central atoms in period 3 or below, like P, S, Cl, and Xe.
- Period 2 elements (C, N, O, F) never have more than 8.

In BF_3 , boron has three bonds, so 6 e^- .

Example: Counting Valence Electrons

Try it first!

How many total valence electrons are in the sulfate ion, SO_4^{2-} ?

Example: Ammonia

Try it first!

Draw the Lewis diagram for ammonia, NH_3 .

Example: Carbon Dioxide

Try it first!

Draw the Lewis diagram for carbon dioxide, CO_2 .

Example: Hydrogen Cyanide

Try it first!

Draw the Lewis diagram for hydrogen cyanide, HCN. Carbon is the central atom.

Example: Ammonium Ion

Try it first!

Draw the Lewis diagram for the ammonium ion, NH_4^+ .

Example: Sulfur Tetrafluoride

Try it first!

Draw the Lewis diagram for sulfur tetrafluoride, SF_4 .

Big Ideas

- Dots show valence electrons.
- Each line is a shared pair (2 electrons).
- Most atoms reach 8 electrons; hydrogen reaches 2.
- Count first, then draw, then check.