A5 · Covalent bonds: bonding capacity, dot diagrams and structural formulas · Notes

Goals: Explain a covalent bond as a pair of electrons shared by two non-metal atoms. Use bonding capacity to decide how many bonds an atom forms and which atom goes in the middle. Draw the electron dot diagram and the structural formula of a molecule with single bonds.

Name: _____ Date: _____

Slide 1 of 8 · Non-metal atoms share electrons

In lesson A3, a metal atom gave electrons to a non-metal atom. Today both atoms are non-metals. Both need electrons, so neither can take them from the other.



two bromine atoms

Each has 7 valence electrons, with 1 single dot.

Key ideas

Two non-metal atoms _____ electrons.

A shared pair of electrons is a _____.

A _____ is a separate group of atoms.

Br_2 means _____ bromine atoms.

Example

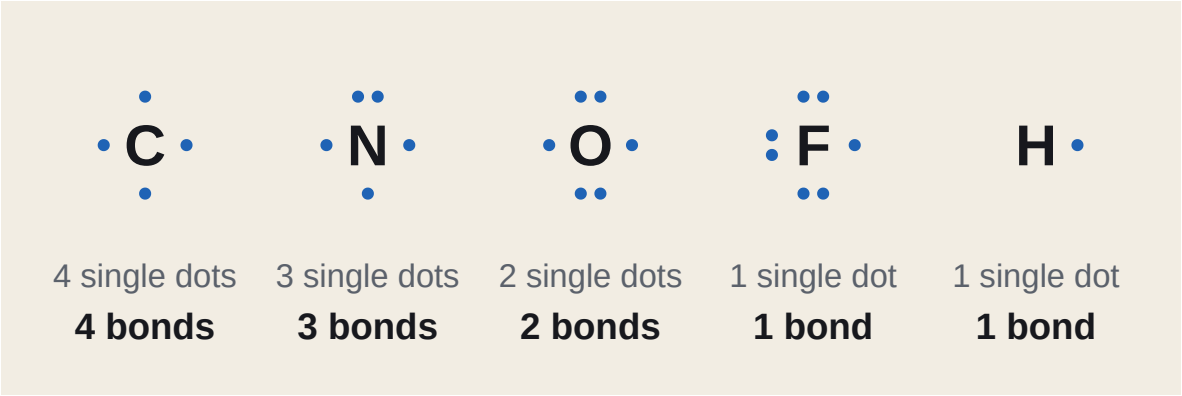
Two chlorine atoms each have 7 valence electrons. How do both atoms get 8?

Try it

What does the molecular formula Cl_2 tell you?

Slide 2 of 8 · Bonding capacity

On the last slide, each bromine atom formed one bond. Other atoms form more. The dot diagram tells you how many.



Key ideas

A single dot is a _____.

The number of bonds an atom forms is its _____.

Carbon has 4 single dots, so it forms _____ bonds.

Group 16 forms _____ bonds.

Example

Sulfur is in group 16. What is its bonding capacity?

Try it

Phosphorus is in group 15. What is its bonding capacity?

Slide 3 of 8 · A molecule with one bond

You can now say how many bonds an atom forms. Next you draw a molecule. Start with the simplest kind, two atoms and one bond.

1



Turn the single dots toward each other.

H has 1 dot. Cl has 7 dots.

Key ideas

Turn the single dots _____.

A shared pair is a _____.

Pairs that are not shared are _____.

Hydrogen has _____ electrons, which fills its outer level.

Example

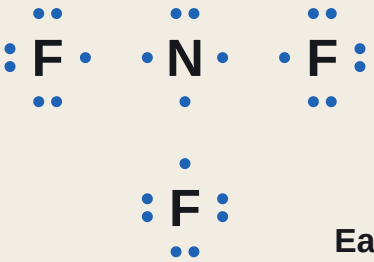
Draw the electron dot diagram of hydrogen fluoride, HF. Say how many bonding pairs and lone pairs it has.

Try it

Draw the electron dot diagram of hydrogen bromide, HBr. Say how many bonding pairs and lone pairs it has.

Slide 4 of 8 · Which atom goes in the middle

HCl had two atoms, so the bond could only go between them. With three or more atoms, one atom goes in the middle. You must decide which.



N forms 3 bonds.
It goes in the middle.

Each F forms 1 bond.
They go on the outside.

Key ideas

The atom with the highest _____ goes in the middle.

In NF_3, _____ is the middle atom.

Hydrogen and the halogens always go on the _____.

Example

Which atom goes in the middle of PCl_3? Say why.

Try it

Which atom goes in the middle of dichloromethane, CH_2Cl_2? Say why.

Slide 5 of 8 · Method: how to draw the electron dot diagram of a molecule

You have now drawn HCl and NF_3. Each time you did the same four things. Here they are as steps.

1. **Draw** each atom's electron dot diagram.
2. **Choose** the middle atom. It forms the most bonds.
3. **Pair** single dots between atoms.
4. **Count** the electrons around each atom.



Check: every atom has 8. Hydrogen has 2.

Used again in: lessons A6 and A9

Key ideas

Step 1: draw the _____.

Step 2: choose the _____ atom.

Step 3: _____ the single dots as pairs.

Step 4: _____. Every atom has 8, and hydrogen has 2.

Example

Use the four steps to draw the electron dot diagram of water, H_2O.

Try it

Use the four steps to draw the electron dot diagram of ammonia, NH_3.

Slide 6 of 8 · The structural formula

The dot diagram of CCl_4 has a lot of dots. Drawing every dot takes time. Chemists use a shorter drawing.

oxygen difluoride, OF_2



electron dot diagram | structural formula

Key ideas

A _____ shows each bonding pair as one dash.

_____ are not drawn.

The number of dashes at an atom equals its _____.

Example

Water has 2 bonding pairs and 2 lone pairs. Draw its structural formula.

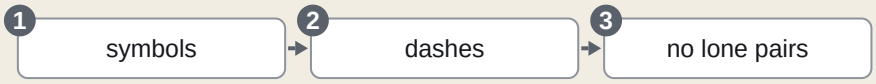
Try it

Ammonia has 3 bonding pairs and 1 lone pair. Draw its structural formula. Say how many dashes it has.

Slide 7 of 8 · Method: how to turn a dot diagram into a structural formula

You just turned two dot diagrams into structural formulas. Each time you did the same three things. Here they are as steps.

1. **Copy** the symbols in the same places.
2. **Draw** one dash for each bonding pair.
3. **Leave out** the lone pairs.



Check: the dashes at each atom equal its bonding capacity.

Used again in: lessons A6 and A9

Key ideas

Step 1: copy the _____ in the same places.

Step 2: draw _____ for the bonding pairs.

Step 3: leave out the _____.

Example

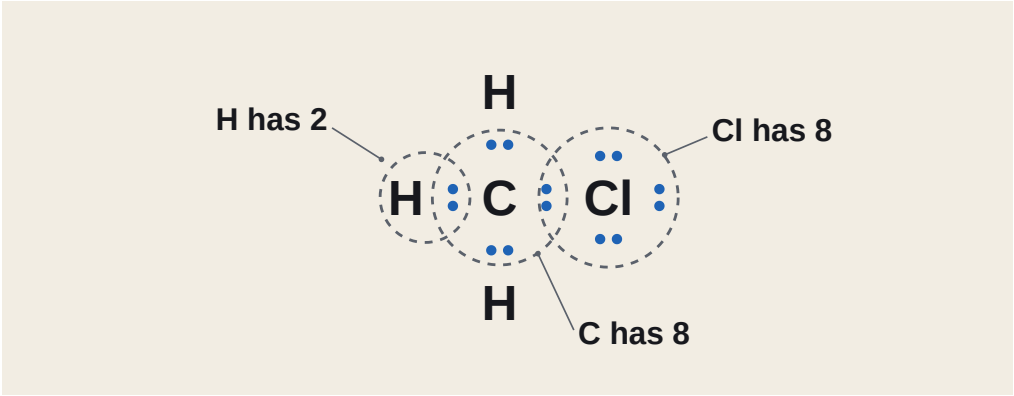
Use the three steps to draw the structural formula of hydrogen chloride, HCl.

Try it

Use the three steps to draw the structural formula of carbon tetrachloride, CCl_4.

Slide 8 of 8 · Check every atom

In lesson A2, the octet rule said a full outer level has 8 electrons. In a molecule, the same rule is a check. A diagram is finished only when every atom passes it.



Key ideas

Count a shared pair for _____.

In CH_3Cl, carbon has 4 bonding pairs. That is _____ electrons.

Each hydrogen has 1 bonding pair. That is _____.

Example

In NF_3, how many electrons are around the nitrogen atom? Show your count.

Try it

In OF_2, how many electrons are around the oxygen atom? Show your count.