Edgenuity

Warm-Up | Covalent Bonding

Lesson Objectives

By the end of this lesson, you should be able to:

- Use the periodic table to determine the number of electrons available for bonding.
- Use the octet rule to predict covalent compounds.
- Construct electron-dot structures (in other words, Lewis structures) to illustrate the arrangement of electrons in covalent structures.
- Explain how covalent bonds affect the properties of covalent compounds.

Science Practice: Develop and use electron-dot models, and explain their usefulness and limitations.

Words to Know

Fill in this table as you work through the lesson. You may also use the glossary to help you.

sigma bond	a type of bond formed from the overlap of *s*, *p*, or *d* orbitals of one atom with *s*, *p*, or *d* orbitals of another atom to allow the atoms to share two electrons
single bond	a type of covalent bond involving one pair of electrons shared between two atoms
double bond	a type of covalent bond involving two pairs of electrons shared between two atoms
triple bond	a type of covalent bond involving three pairs of electrons shared between two atoms
resonance structures	a condition that results when two or more Lewis structures can be drawn from a molecular formula; the actual structure is a blend of the resonance structures

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Words to Know

pi bond	an overlap of *p*-orbitals of one atom with *p*-orbitals of another atom to allow additional sharing of electrons beyond those shared in a sigma bond
nonpolar bond	a bond characterized by the equal sharing of bonding electrons between two atoms
bonding electrons	the electrons shared between two atoms joined in a covalent bond
octet rule	the general principle that atoms of nonmetals tend to be most stable when their valence shells are filled with eight electrons
expanded octet	a condition of some atoms having empty *d*-orbitals that can be used for bonding, allowing for more than eight valence electrons to be involved in bonding
nonbonding electrons	the valence electrons in an atom that do not participate in bonding with another atom
polar bond	a bond characterized by bonding electrons having greater association with one atom than another atom

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Slide 1

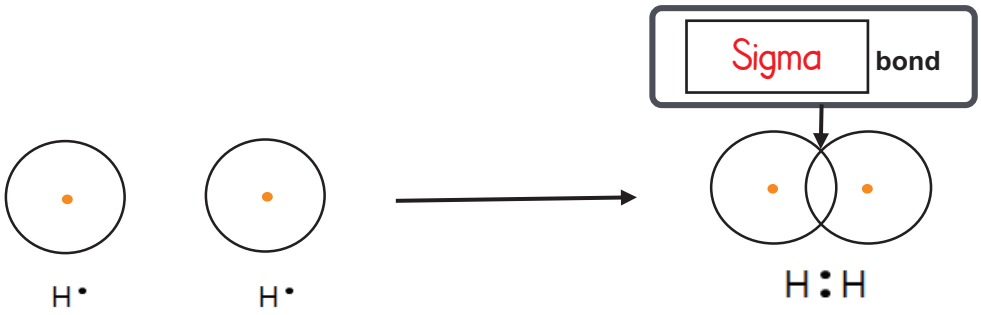
Lesson Question

How do scientists predict whether a covalent bond will form?
How are covalent bonds illustrated?

Slide 2

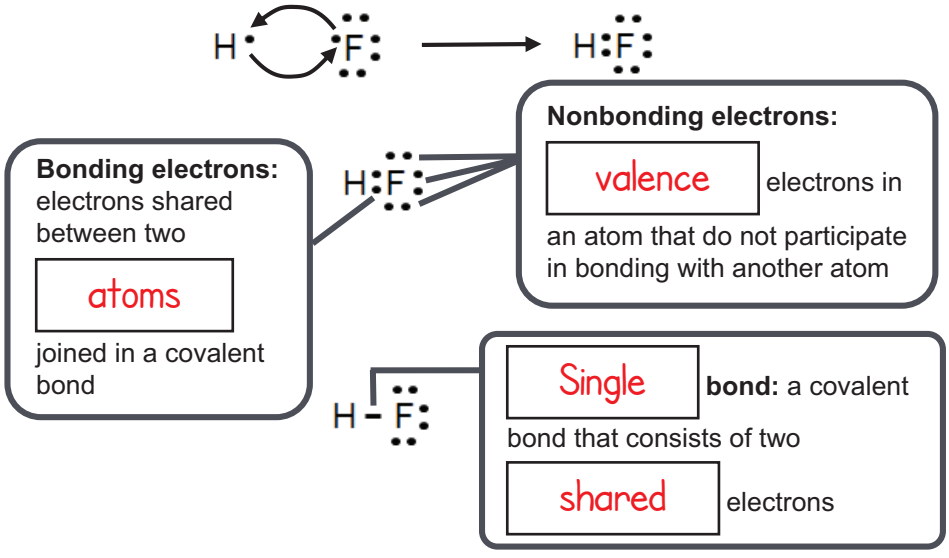
Orbital Overlap

Covalent bonds form when two [nonmetals] share valence electrons.



A sigma bond results from the direct [overlap] of an *s*, *p*, or [*d*] orbital of one atom with an [*s*], *p*, or *d* orbital of another atom.

Bonding and Nonbonding Electrons



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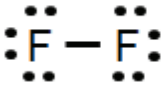
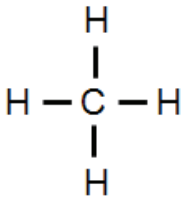
Equal and Unequal Sharing of Electrons

Nonpolar **bond**:



a bond characterized by the equal sharing of bonding electrons between two atoms

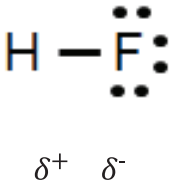


- Little or no difference in electronegativity: ≤ 0.4
- Equal sharing of electrons

Polar **bond**:

a bond characterized by bonding electrons having greater association with one atom than another atom

- Atoms differ in electronegativity: ≥ 0.5
- Unequal sharing of electrons
- Partial charges develop



δ^+ δ^-

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Lewis Structures of Atoms

Lewis structures:

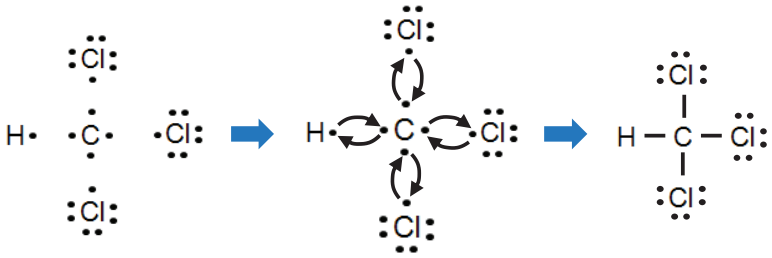
- use chemical symbols.
- show valence electrons.

Instruction | Covalent Bonding

Slide 7

Drawing Lewis Structures of Molecules

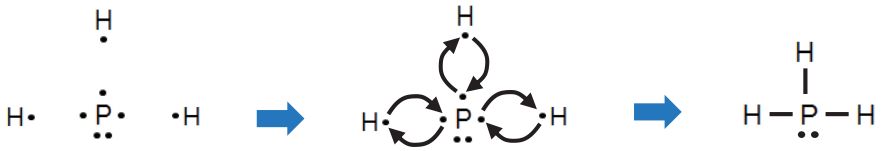
Draw the Lewis structure of [$CHCl_3$]:



1. Draw the Lewis symbols of the [atoms] in the structure.
2. Form [covalent] bonds between atoms.
3. Draw the [final] structure with dashes to represent bonds.

Lines represent each bonding pair of [electrons]. Dots represent [non-bonding] electrons.

Applying the Octet Rule



1. Draw the [Lewis] symbols of the atoms in the structure.
2. Form covalent bonds between atoms.
3. The leftover electrons stay with the [central] atom.

Octet rule: the general principle that atoms of [nonmetals] tend to be most stable when their valence [shells] are filled

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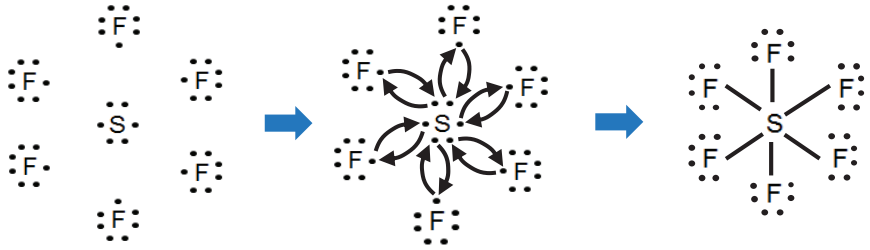
Exceptions to the Octet Rule



1. Draw the Lewis [symbols] of the atoms in the structure.
2. Form covalent bonds between atoms.
3. Any extra electrons stay with the [central] atom.

[Expanded] **octet**: condition of some atoms having empty [*d*]-orbitals that can be used for bonding; allows for more than [eight] valence electrons to be involved in bonding

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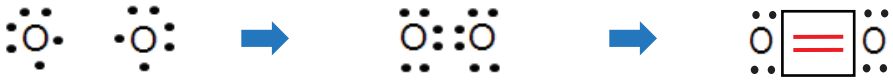
Double Bonds



1. Draw the Lewis symbols for the atoms.
2. [Four] electrons must be shared between each [O].

Double bond: a type of covalent [bond] involving [two] pairs of electrons shared between two atoms

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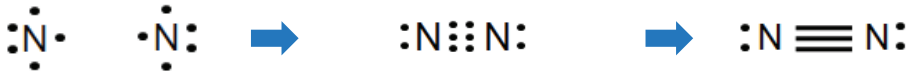
Triple Bonds



1. Draw the [Lewis] symbols for the atoms.

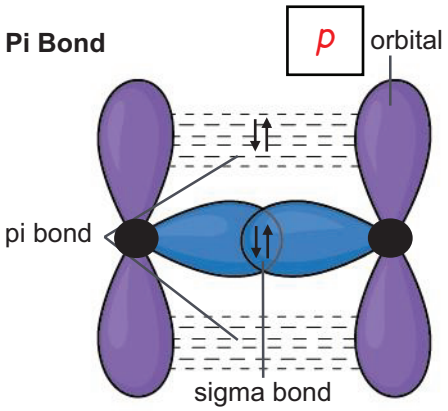
2. [Six] electrons must be shared between each [N].

Triple bond: a type of covalent bond involving [three] pairs of electrons shared between two atoms

Orbital Overlap and Pi Bonds

pi bond (p)

- Overlap of *p*-orbitals of one atom with *p*-orbitals of another atom to allow additional sharing of electrons beyond those shared in a sigma bond
- The combination of [pi] and sigma bonds creates double and [triple] bonds.



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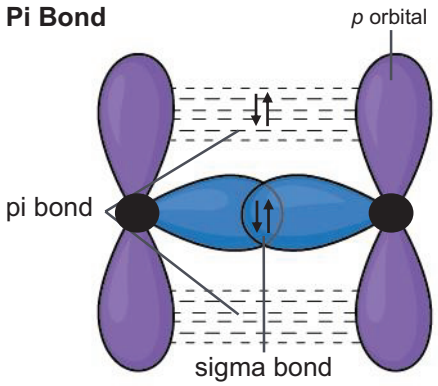
Orbital Overlap and Pi Bonds

Double bond:

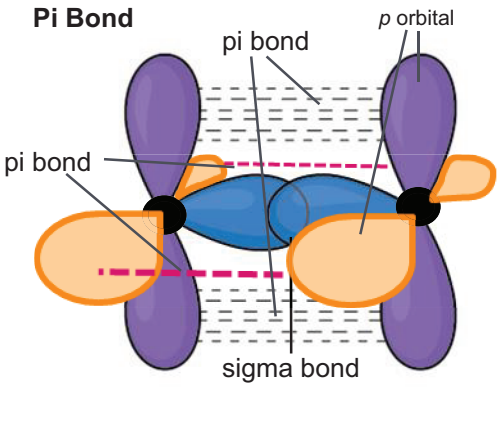
- One sigma bond (σ)
- One **pi bond** (π)
  - Overlap of two *p*-orbitals



Orbital Overlap and Pi Bonds

Triple bond:

- One sigma bond (σ)
- Two pi bonds (π)
- Second pi bond oriented 90° from the first



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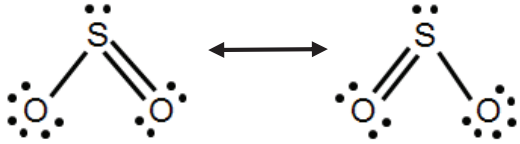
Resonance Structures

Resonance structures:

- result when two or more Lewis structures can be drawn from a single molecular formula.
- are a blend of resonance structures.



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Properties of Covalent Compounds

Properties:

- are composed of molecules.
- do not ionize in solution.
- are poor conductors of electrical charge.
- are poor conductors of heat.
- have low melting points and boiling points.
- are gases or liquids at room temperature (if compounds are small).

Summary | Covalent Bonding

Lesson Question

How do scientists predict whether a covalent bond will form? How are covalent bonds illustrated?

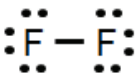
Answer

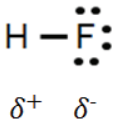
(Sample answer) The scientists can predict that a covalent bond would form when two atoms share their electrons to form a bond. The covalent bonds are illustrated with the help of Lewis structures.

Slide 2

A Model for Covalent Compounds

- Covalent bonds result from two [nonmetals] sharing valence electrons.
- Orbital [overlap] allows atoms to share electrons.
- Depending on the atoms, electrons may be shared equally or unequally.
- Bonds may be [polar] or nonpolar depending on the degree of sharing.





Summary | Covalent Bonding

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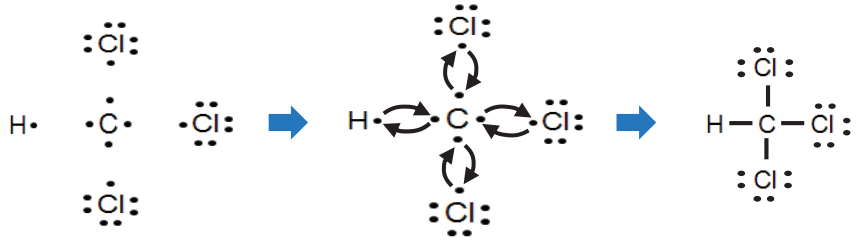
Simple Lewis Structures

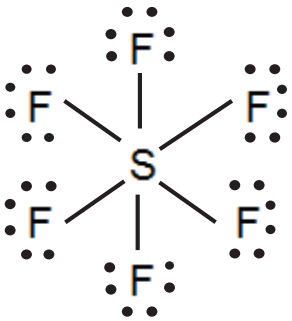
Follow the basic steps for drawing Lewis structures:



1. Draw the Lewis [symbols] of the atoms in the structure.
2. Form covalent bonds between [atoms].
3. Draw the final structure with dashes to represent [bonds].

More Complex Lewis Structures

- Expanded [octets]
- [Double] bonds
- Triple bonds
- Resonance structures



Summary | Covalent Bonding

Slide 2

Properties of Covalent Compounds

- Covalent bonds are strong and do not break easily.
- Covalent compounds do not have strong intermolecular attractions.
  - Intermolecular forces exist between molecules, not between atoms within a molecule.
- As a result of these structural features, covalent compounds:
  - do not ionize in solution.
  - are poor conductors of electric charge.
  - are poor conductors of heat.
  - have low melting points and boiling points.

Use this space to write any questions or thoughts about this lesson.