

Single Covalent Bonds

Ck12 Science

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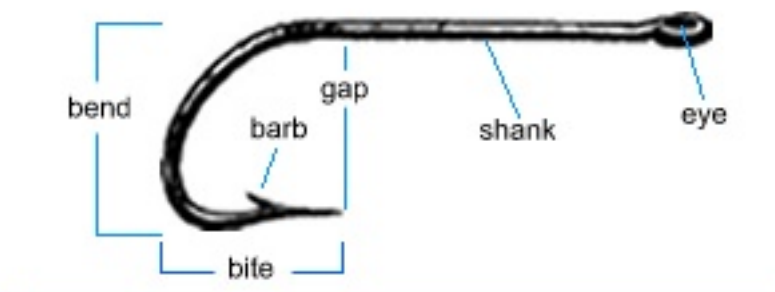


CHAPTER

1

Single Covalent Bonds

- Define a single covalent bond.
- Draw Lewis dot structures of molecules containing single covalent bonds.



What holds molecules together?

In one form or another, the idea of atoms connecting to form larger substances has been with us for a long time. The Greek philosopher Democritus (460-370 BC) believed that atoms had hooks on them that allowed atoms to connect with one another. Today we believe that atoms are held together by bonds formed when two atoms share a set of electrons, a much more complicated picture than the simple hooks that Democritus preferred.

Single Covalent Bonds

A covalent bond forms when two orbitals with one electron each overlap each other. For the hydrogen molecule, this can be shown as:

Hydrogen

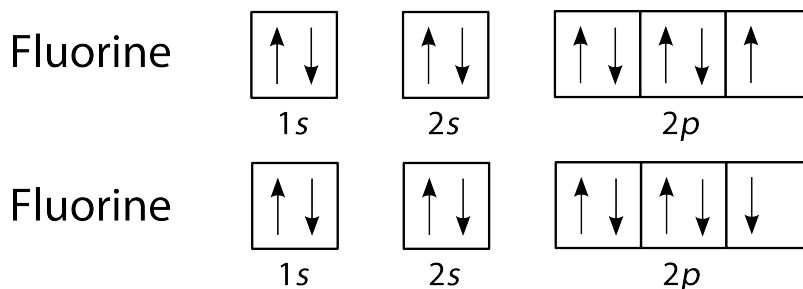


Hydrogen



Upon formation of the H_2 molecule, the shared electrons must have opposite spin, so they are shown with opposite spin in the atomic 1s orbital.

The halogens also form single covalent bonds in their diatomic molecules. An atom of any halogen, such as fluorine, has seven valence electrons. Its unpaired electron is located in the $2p$ orbital.



The single electrons in the third 2p orbital combine to form the covalent bond:

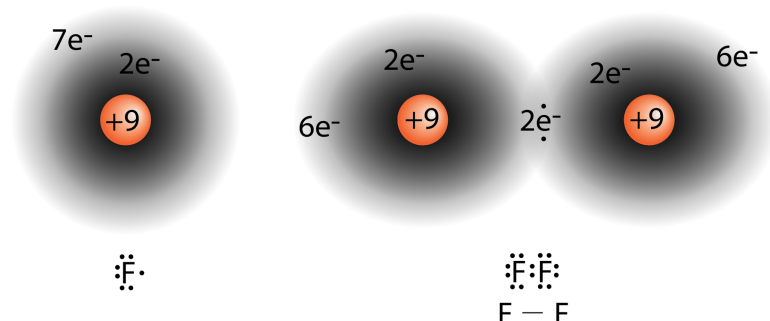
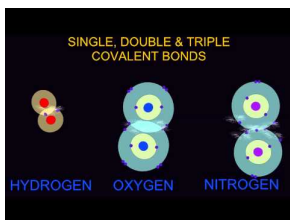


FIGURE 1.1

On the left is a fluorine atom with seven valence electrons. On the right is the F_2 molecule.

The diatomic fluorine molecule (F_2) contains a single shared pair of electrons. Each F atom also has three pair of electrons that are not shared with the other atom. A **lone pair** is a pair of electrons in a Lewis electron-dot structure that is not shared between atoms. The oxygen atom in the water molecule shown below has two lone pair sets of electrons. Each F atom has three lone pairs. Combined with the two electrons in the covalent bond, each F atom follows the octet rule.



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Sample Problem 9.1: Lewis Electron Dot Structures

Draw the Lewis electron dot structure for water.

Step 1: List the known quantities and plan the problem.

Known

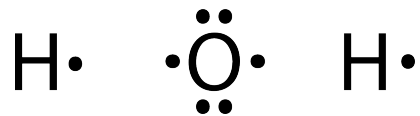
- molecular formula of water = H_2O
- 1 O atom = 6 valence electrons
- 2 H atoms = $2 \times 1 = 2$ valence electrons

- total number of valence electrons = 8

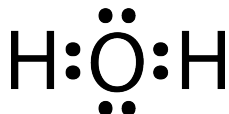
Use the periodic table to determine the number of valence electrons for each atom and the total number of valence electrons. Arrange the atoms and distribute the electrons so that each atom follows the octet rule. The oxygen atom will have 8 electrons, while the hydrogen atoms will each have 2.

Step 2: Solve.

Electron dot diagrams for each atom are:



Each hydrogen atom with its single electron will form a covalent bond with the oxygen atom where it has a single electron. The resulting Lewis electron dot structure is:



Step 3: Think about your result.

The oxygen atom follows the octet rule with two pairs of bonding electrons and two lone pairs. Each hydrogen atom follows the octet rule with one bonding pair of electrons.



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Summary

- Covalent bonds form when electrons in two atoms form overlapping orbitals.
- Lone pair electrons in an atom are not shared with another atom.

Review

1. How does a covalent bond form?
2. What do the spins of the shared electrons need to be?
3. Do lone pair electrons form covalent bonds?

- **lone pair:** A pair of electrons in a Lewis electron-dot structure that is not shared between atoms.

References

1. Courtesy of the US Department of the Interior. <http://commons.wikimedia.org/wiki/File:Fishhook.jpg> .
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