Covalent Bonds

A covalent bond occurs when two nonmetals **share** electrons to achieve a stable electron configuration.

The result of a covalent bond is a molecule (the result of an ionic bond is a formula unit).

The covalent bond seems to be an overlap and mixing of orbitals from two different atoms.

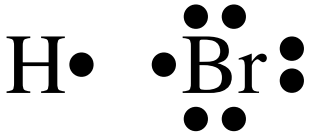
In many cases more than one compound can be formed from covalent bonds between two elements.

Dot Structures

When we draw dot structures for covalent compounds we indicate the shared electrons with a dash to represent two electrons between the two symbols.

Example: hydrogen and bromine

Hydrogen has one valence electron, bromine has 7 valence electrons.

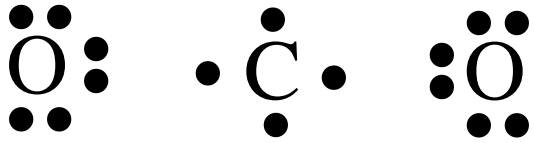


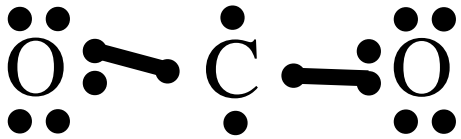
Double Covalent Bond

Sometimes elements need more than one bond to become stable. When two pairs of electrons (4 electrons total) are shared it is called a double covalent bond.

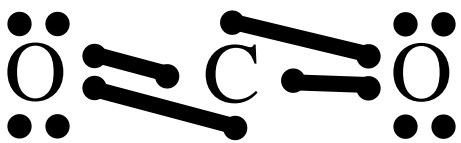
carbon dioxide is an example.

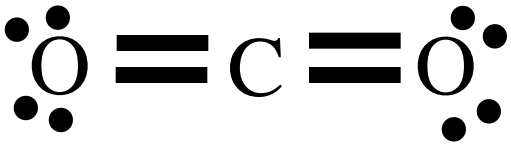
carbon has 4 valence electrons, oxygen has 6





With only one bond neither is “satisfied”

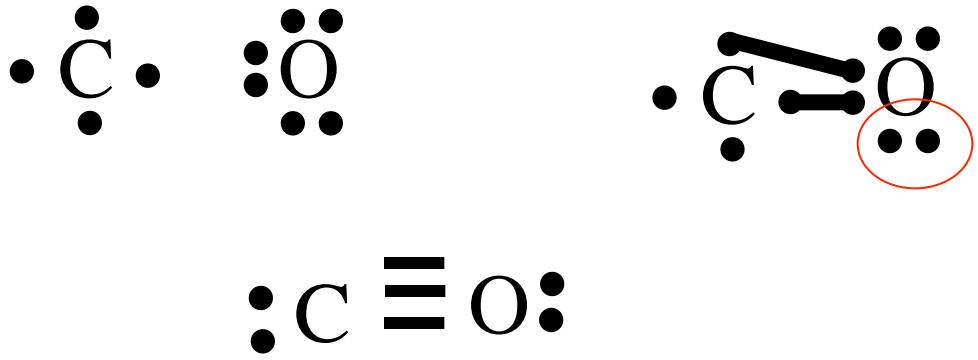




Triple Covalent Bond

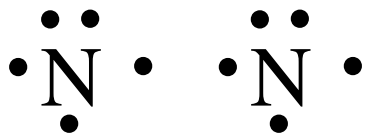
Sometimes even a double bond is not enough sharing to cause the elements to be stable. In some cases it is necessary to form a triple covalent bond that is a sharing of 3 pairs of electrons.

An example is carbon monoxide, CO



Nitrogen

Another example is nitrogen. Nitrogen is a diatomic element. This means that two nitrogen atoms (diatomic) form one molecule.



Diatomic Elements

There are 8 elements that form diatomic molecules.

You need to know these.

3 ways to remember:

1. The rule of 7's + 1
2. Elements that end in gen or ine
3. memorize the list

Covalent Names

Many elements can combine in multiple ways for covalent bonds. The two forms of carbon oxide (CO and CO_2) are one example.

To provide unique names for these different formulas prefixes are used for the covalent bonds when hydrogen is not one of the elements.

Prefixes

When more than one compound can be formed between the two nonmetals (two nonmetals where neither is hydrogen) prefixes are used in the name to indicate the number of atoms **except** that "mono" is never used on the first atom.

Prefixes

mono=1 di=2 tri=3 tetra=4 penta=5

hexa=6 hepta=7 octa=8 nona=9 deca=10

Writing Formulas

When writing the formulas for covalent compounds simply follow the prefixes that the name provides.

Electrons are being shared so don't try to figure out charges for the ions - there aren't any.

The element with the lowest electronegativity is written first (treated as the cation).

Examples

carbon dioxide

CO_2

sulfur trioxide

SO_3

diiodine pentoxide

I_2O_5

silicon tetrafluoride

SiF_4

Polar Covalent Compounds

Normal life is not just black and white - there are shades of gray.

Polar covalent compounds are formed when there is an "unequal sharing" of electrons.

The unequal sharing is caused by a difference in electronegativity between the elements.

The only true pure covalent compounds are those formed from the same element.

Other compounds will have different amounts of polarity ranging from almost equal sharing to a transfer of electrons.

What is black, what is white?

Determining the polarity

The first step in determining the bond type is to calculate the difference in electronegativity.

The dividing line for each of the bond types is an artificial line

Electronegativity Difference	Bond Type
0.0 to 0.4	Nonpolar Covalent
0.4 to 1.5	Polar Covalent
Greater than 1.5	Ionic

Identifying Polar Bonds

The only difference in identifying polar covalent bonds from covalent bonds is when dot structures are drawn.

Water is a classic example of a polar covalent bond.

hydrogen has an electronegativity of 2.20

oxygen has an electronegativity of 3.50

The difference in electronegativity is 1.30 - polar covalent

Dot Diagrams of Polar Bonds

Water - H_2O