

Molecular Compounds

Atoms that share electrons form **covalent bonds**. In a covalent bond, the shared electrons are considered to be part of the complete outer orbit of both atoms involved. The majority of covalent bonds form between nonmetallic elements.

A **molecule** is formed when two or more atoms bond covalently. Covalently bonded compounds are, therefore, known as **molecular compounds**.

Lewis Dot Diagrams

A **Lewis dot diagram** consists of an element's symbol surrounded by dots representing the atom's valence electrons. The dots are placed one at a time on the four sides of the symbol, and then paired up until all are used. Lewis dot diagrams for several elements are shown below:

1A	2A					7A	8A
						·H	:He
						Hydrogen	Helium
Li ·	·Be ·	·B ·	·C ·	·N ·	·O ·	·F ·	:Ne :
Lithium	Beryllium	Boron	Carbon	Nitrogen	Oxygen	Fluorine	Neon
Na ·	·Mg ·	·Al ·	·Si ·	·P ·	·S ·	·Cl ·	:Ar :
Sodium	Magnesium	Aluminum	Silicon	Phosphorus	Sulfur	Chlorine	Argon

Diatomic Molecules

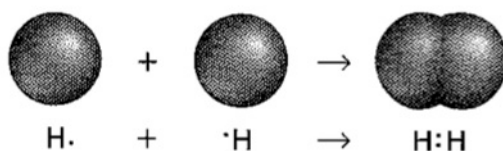
A **diatomic molecule** consists of two atoms of the same element bonded together covalently. This occurs because the resulting molecular compounds are more stable than the individual atoms.

The following elements form diatomic molecules:

Element	Diatomic Molecule	Name
Hydrogen	H_2	Hydrogen gas
Nitrogen	N_2	Nitrogen gas
Oxygen	O_2	Oxygen gas
Fluorine	F_2	Fluorine gas
Chlorine	Cl_2	Chlorine gas
Bromine	Br_2	Bromine gas
Iodine	I_2	Iodine gas

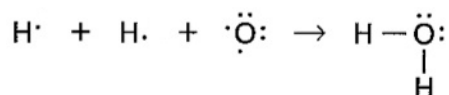
Single Covalent Bonds

When a single pair of electrons is shared, such as in a hydrogen molecule (H_2), a single covalent bond forms. The shared electron pair is represented by a line in the Lewis structure for the molecule. For example, a hydrogen molecule is represented as

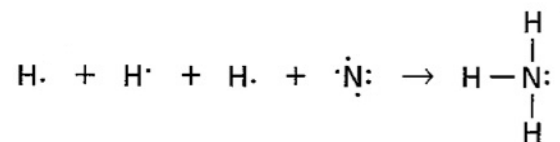


The halogens (group 7A) need one electron to form an octet. Thus, halogens will form single covalent bonds. They will either do this with another identical atom, forming a diatomic molecule, or with another element, such as carbon.

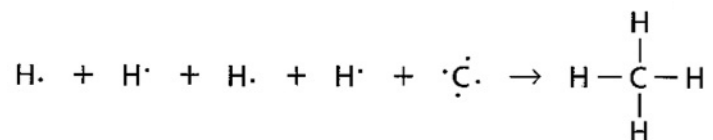
The chalcogens (group 6A) share two electrons to form covalent bonds. They can do this by sharing a single electron with each of two other elements, thus forming two single covalent bonds. Water is an example of a molecular compound containing two single covalent bonds.



Group 5A elements will form three covalent bonds. Ammonia (NH_3) is an example of a molecular compound containing three single covalent bonds.



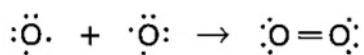
Group 4A elements will form four covalent bonds. A methane molecule (CH_4) is formed when one carbon atom forms four single covalent bonds with four hydrogen atoms.



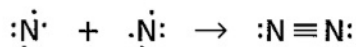
Multiple Covalent Bonds

In many molecules, atoms attain a full octet by sharing more than one pair of electrons between two atoms, forming a multiple covalent bond. Atoms of the elements carbon, nitrogen, oxygen, and sulfur most often form multiple bonds.

A double covalent bond occurs when two pairs of electrons are shared between two atoms. The atoms in an oxygen molecule (O_2) share two electron pairs, forming a double bond.



A triple covalent bond is formed when three pairs of electrons are shared between two atoms. Nitrogen (N_2) shares three electron pairs, producing a triple bond.



Naming Binary Molecular Compounds

Binary covalent compounds are formed between two nonmetals. They are named very similarly to binary ionic compounds.

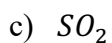
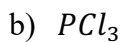
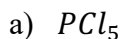
1. The first element in the formula is always named first, using the full element name.
2. The second element in the formula is named using the root of the element and adding the suffix *-ide*.
3. Prefixes are used to indicate the number of atoms of each element that are present in the compound.
4. The prefix *mono-* is never used for naming the first element.

Prefix	Number it Represents
mono	1
di	2
tri	3
tetra	4
penta	5
hexa	6
hepta	7
octa	8
nona	9
deca	10

To avoid awkward pronunciation, drop the final letter in the prefix when the element name begins with a vowel. For example, *CO* is carbon monoxide, not carbon monooxide.

Example 1

Name each of the following compounds:



Example 2

Write the formula for each of the following compounds:

a) sulfur hexafluoride

b) sulfur trioxide

c) carbon dioxide

Many binary molecular compounds were discovered and given common names long before the modern naming system was developed. The table below lists some of these molecules, their common names, and the binary molecular compound names.

Formula	Common Name	Molecular Compound Name
H_2O	water	dihydrogen monoxide
NH_3	ammonia	nitrogen trihydride
N_2H_4	hydrazine	dinitrogen tetrahydride
N_2O	nitrous oxide (laughing gas)	dinitrogen monoxide
NO	nitric oxide	nitrogen monoxide

Molecular Compounds

1. What is the difference between an ionic compound and a molecular compound?
2. What kinds of atoms form molecular compounds? How do these atoms form compounds? What type of bond holds the atoms together in a molecular compound?
3. How many valence electrons are there in a fluorine atom? How many electrons does a fluorine atom need to share to have a full outer orbit of electrons? Draw a sketch to show how two fluorine atoms could form a stable molecule.
4. Some elements form diatomic molecules. Where are these elements generally located on the periodic table?
5. Name the following compounds:
 - a) CBr_4
 - b) NI_3
 - c) OF_2
 - d) $SiCl_4$
 - e) P_2O_5
6. Write chemical formulas for and name the compounds formed from the following pairs of elements.
 - a) Silicon and oxygen
 - b) Nitrogen and hydrogen
 - c) Phosphorus and chlorine
 - d) Sulfur and bromine
 - e) Carbon and chlorine