

Molecular Compounds

Molecules are combinations of two or more atoms.

Molecular element - if the atoms are all the same

For example oxygen gas is a molecule composed of two atoms of oxygen. Since there are two atoms the molecule is called a diatomic molecule.

Oxygen	O ₂
Hydrogen	H ₂
Nitrogen	N ₂

Compound - a molecule that contains two or more different types of atoms or ions.

- Water (H_2O) is a compound because it contains both Hydrogen and Oxygen, two different types of atoms.
- The formula for water (H_2O) is a combination of symbols and subscripts.
- H and O are the symbols for the two types of elements (Hydrogen and Oxygen) found in water.
- The number 2 to the lower right hand corner of the symbol for Hydrogen is called a subscript.
- a molecular formula indicates the total number of atoms in one molecule
- an empirical formula is the simplest whole number ratio of atoms in the compound.
- consider hydrogen peroxide (H_2O_2) as an example.
 - the molecular formula is H_2O_2 .
 - the empirical formula is HO. (lowest ratio is 1:1)

Chemical Bonding:

Chemical bonding is the force of attraction between atoms.

- two types of bonding: covalent and ionic.

Covalent Bonding (molecular compounds):

- the force of attraction between two or more non-metals
- recall the position of non-metals to the right of the steps on the periodic table.
- the two non-metals both want to gain electrons (to be like the noble gases), since both cannot gain electrons at the same time they share.

Co-valent (sharing of valence electrons)

- the unit formed by a covalent bond is called a molecule (it is neutral it has no charge)



Ionic Bonding

- force of attraction between a positive ion (cation) and a negative ion (anion).
- ionic compounds
- the force of attraction between a metallic ion and a non-metallic ion. (or complex ion)
- or, they are made up of two oppositely charged ions.

Examples:

NaCl (sodium chloride)

NaHCO₃ (sodium bicarbonate - baking powder)

CaCO₃ (calcium carbonate - rolaids/tums)

the unit formed by an ionic compound is a formula unit

formula units are very complex crystal lattice arrangements

the smallest crystal of sodium chloride is really (Na⁺)₆(Cl⁻)₆

to keep things simple we reduce this down to an empirical formula (lowest whole number ratio) of NaCl.

Five categories of molecular compounds:

1. mono atomic elements
2. diatomic elements
3. polyatomic elements
4. trivial (common) compounds
5. binary molecular compounds

1. Mono-atomic elements

If we look at the name of the heading, mono - means one, so these are the non-metals that exist in nature as individual atoms. Although these are not compounds we have included them here because we will reference them many times.

Noble Gases (group 18)

He Helium

Ne Neon

Ar Argon

Kr Krypton

Xe Xenon

Rn Radon

2. Diatomic molecular elements

As the heading suggest these are elements composed of two (di) nonmetal atoms.

oxygen O_2

hydrogen H_2

nitrogen N_2

the halogens (group 17)

fluorine F_2

chlorine Cl_2

bromine Br_2

iodine I_2

3. Polyatomic molecular elements

These are non-metal elements composed of many (poly) atoms.

O ₃	ozone
S ₈	sulfur
P ₄	phosphorus (red)
P ₁₀	Phosphorus (white)

4. Trivial Names: Common names.

Despite the IUPAC rules for naming many molecular compounds still go by their trivial (common) names.

Here is a list of the molecular compounds with trivial names that you need to know:

O ₃	ozone
H ₂ O	water
H ₂ O ₂	hydrogen peroxide
NH ₃	ammonia
CH ₄	methane
CH ₃ OH	methanol
C ₂ H ₅ OH	ethanol
C ₁₂ H ₂₂ O ₁₁	sucrose

5. Binary Molecular Compounds

These are molecular compounds that contain two different non-metal atoms.

- binary - 2
- molecular - non-metal atoms only
- compound - two different atoms

Carbon dioxide - CO_2 is a common example. It consists of carbon atoms and oxygen atoms.

IUPAC Prefixes from 1 - 10

IUPAC stands for International Union of Pure and Applied Chemistry

The IUPAC rules for naming and formula writing involve use of a prefix system that indicates the number of atoms present.

You must know this list (first ten prefixes) in order to convert formula to names or to convert names to formulas.

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

Naming binary molecular compounds:

- Write the name of the first element of the formula in full.
- Shorten the name of the second element and add the ide ending.
- Use prefixes to indicate the number of atoms of each element in the molecular formula.
- The prefix mono on the first name is optional.

Sample Exercise:

Write a IUPAC name for CCl_4 .

Answer

- The first element is C.
- Its full name is carbon.
- The second element is chlorine.
- Its name is shortened to chlor, and the prefix -ide is added to give chloride.
- The prefix mono (1) is added to carbon, and the prefix tetra (4) is added to chloride to give the name: monocarbon tetrachloride.
- The prefix mono is omitted from the first element name to give carbon tetrachloride.

What is the IUPAC name for CF_4 ?

What is the IUPAC name for SiO_2 ?

What is the IUPAC name for SO_3 ?

What is the IUPAC name for P_4S_3 ?

Rules For Writing Molecular Formulas:

Write the symbols for each element in the compound.

Use the prefix to determine the number of atoms of each element in the formula and write the appropriate number as a subscript to the right of the element's symbol.

If an element name lacks a prefix, assume that there is just one atom of that element. It is not necessary to write the numerical subscript 1 since it is implied.

Sample Exercise:

Write the formula for diboron hexahydride.


Answer:

- The compound contains boron and hydrogen atoms.
- Diboron means that the molecule contains two boron atoms (B_2)
- hexahydride means the molecule contains six hydrogen atoms (H_6).
- Bringing the two symbols together in the order they appear in the name gives.

The formula for diboron hexahydride is B_2H_6 .



Write the molecular formula for each of the following compounds:

1. nitrogen triiodide
 2. triphosphorus pentabromide
 3. carbon disulfide
 4. sulfur trioxide
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Homework: Complete worksheet

