

Nomenclature & Formula Writing 7

Writing Formulas & Names for Molecular Compounds

INFORMATION

Molecular compounds (sometimes called covalent compounds) follow a completely different set of rules for naming and formula writing than ionic compounds. The bonds in molecular compounds are **covalent**. The word covalent means “shared (*co-*) valence (*-valent*),” or, more appropriately, “shared valence electrons.” Ions are not formed for the creation of molecular compounds. The atoms in a molecular compound share their electrons between them rather than exchanging them. This sharing allows both atoms to take advantage of the electrons for the purpose of filling their outer shells, and it results in a lower-energy, more stable state than the individual, free-state elements can attain on their own.

Sharing allows both atoms to take advantage of the electrons for the purpose of filling their outer valence shells.

For example, in the molecular compound H_2 (this is a special case, see below), the single electron in each hydrogen atom (a total of two) is shared between both hydrogen atoms. This results in each hydrogen atom having two electrons about half of the time, creating an “average” situation in which both atoms have full outer shells (recall that hydrogen can only have two electrons in its outer shell).

In the real world, some metals can form covalent bonds with other atoms. For the purpose of this activity, however, *molecular compounds are formed only from nonmetals*.

Writing Names for Molecular Compounds

The names for molecular compounds are not derived from charge, since they are not ionic in nature. Instead, they are written using specific prefixes on each element to designate the number of atoms of that element that are present in the compound. The prefixes are listed below.

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

The prefix chosen for an element must correspond to the numerical subscript on that atom. For example, in the compound N_2O_3 , there are 2 nitrogen atoms and three oxygen atoms. The compound, therefore, is called *dinitrogen trioxide*. Note that the oxygen on the right side of the compound gets the *-ide* suffix. This is similar to the convention used with many ionic compounds.

The prefix *mono-* is not used on the leading element. For example, CO_2 is *carbon dioxide*, not *monocarbon dioxide*.

There are some compounds, especially those formed by metalloids and semiconductors, whose formulas are ambiguous in terms of determining name for those compounds. For example, SiO_2 , strictly speaking, is a molecular compound since silicon is a nonmetal (albeit barely, which is why it is a

metalloid). The name of this compound is silicon dioxide. Germanium, however, which is also a metalloid (again, barely a metal), when bonded with oxygen is sometimes referred to as germanium dioxide, while its ionic name is actually germanium oxide. In these cases, use the most logical convention – if both atoms are nonmetals, use their molecular name. If there is a metal involved, use the ionic name.

Writing Formulas for Molecular Compounds

Writing formulas for molecular compounds is the reverse of the naming procedure. The subscript for each element must correspond to the prefix. Remember that the absence of a prefix on the leading element is an understood “*mono-*” which indicates that there is only one atom of that element present in the compound.

Unlike in ionic compounds, subscripts that share a common factor do not get reduced. For example, As_4O_{10} does not simplify to As_2O_5 .

HONCIBrIF, P₄, S₈

The seven elements hydrogen, oxygen, nitrogen, chlorine, bromine, iodine, and fluorine always form diatomic (2 atoms) molecular compounds with themselves when they are in their free state (elemental, unbonded) forms. However, they do not follow the naming convention for other “two-element” molecular compounds – they are simply named as the element they are. H_2 , O_2 , N_2 , Cl_2 , Br_2 , I_2 , and F_2 are the forms that these seven elements take when they are not bonded with other elements, and are named, respectively, hydrogen, oxygen, nitrogen, chlorine, bromine, iodine, and fluorine. At standard temperature and pressure, all of these elements are gases, except for bromine, which is a liquid.

Also, when in their free-state forms, phosphorus sometimes forms P_4 molecules (known as white phosphorus), and sulfur forms S_8 molecules. These are both solids at standard temperature and pressure (STP, 273K and 1 atm).



Key Questions

1. Explain why molecular compounds do not use charges to determine formulas in the same manner as ionic compounds.
2. In grammatically correct English, write detailed procedures for a) writing molecular formulas and b) naming molecular compounds. Assume that the procedures will be used by someone who has no prior knowledge of this material.

Student Name: _____ Pd. _____ Date: _____

Supplementary Exercises
Molecular Compound Naming and Formula Writing

Write the correct name for the following compounds.

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|------------------------------------|------------------------------------|------------------------------------|
| 1. KrF ₂ | 11. NI ₃ | 21. CO ₂ |
| 2. BrCl ₅ | 12. SF ₆ | 22. SO ₃ |
| 3. SCl ₄ | 13. XeF ₄ | 23. XeF ₆ |
| 4. PF ₃ | 14. PCl ₃ | 24. ICl ₂ |
| 5. CO | 15. P ₂ O ₅ | 25. SO ₂ |
| 6. PCl ₅ | 16. S ₂ Cl ₂ | 26. P ₄ O ₁₀ |
| 7. As ₄ O ₁₀ | 17. ClO ₂ | 27. SF ₆ |
| 8. BrO ₃ | 18. SiO ₂ | 28. OF ₂ |
| 9. BN | 19. BF ₃ | 29. XeO ₃ |
| 10. N ₂ O ₃ | 20. N ₂ S ₅ | 30. AsO ₄ |

Write the correct formula for the following compounds.

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|-----------------------------|-------------------------------|
| 1. sulfur tetrachloride | 17. sulfur trioxide |
| 2. xenon trioxide | 18. dinitrogen trioxide |
| 3. carbon dioxide | 19. phosphorus trichloride |
| 4. diphosphorous pentoxide | 20. carbon monoxide |
| 5. phosphorous trichloride | 21. boron monophosphide |
| 6. sulfur dioxide | 22. dinitrogen monoxide |
| 7. bromine pentafluoride | 23. nitrogen trifluoride |
| 8. disulfur dichloride | 24. dinitrogen monoxide |
| 9. chlorine monoxide | 25. xenon hexafluoride |
| 10. oxygen difluoride | 26. sulfur hexafluoride |
| 11. boron trichloride | 27. phosphorous pentachloride |
| 12. dinitrogen pentasulfide | 28. nitrogen monoxide |
| 13. silicon tetrachloride | 29. boron trifluoride |
| 14. krypton difluoride | 30. tetraarsenic decoxide |
| 15. chlorine monoiodide | |
| 16. silicon dioxide | |