

# Naming Molecular Compounds

How are the chemical formula and name of a molecular compound related?

## Why?

When you began chemistry class this year, you probably already knew that the chemical formula for carbon dioxide was  $\text{CO}_2$ . Today you will find out why  $\text{CO}_2$  is named that way. Naming chemical compounds correctly is of paramount importance. The slight difference between the names carbon monoxide ( $\text{CO}$ , a poisonous, deadly gas) and carbon dioxide ( $\text{CO}_2$ , a greenhouse gas that we exhale when we breathe out) can be the difference between life and death! In this activity you will learn the naming system for molecular compounds.

## Model 1 – Molecular Compounds

Molecular Formula	Number of Atoms of First Element	Number of Atoms of Second Element	Name of Compound
$\text{ClF}$			Chlorine monofluoride
$\text{ClF}_5$	1	5	Chlorine pentafluoride
$\text{CO}$			Carbon monoxide
$\text{CO}_2$			Carbon dioxide
$\text{Cl}_2\text{O}$			Dichlorine monoxide
$\text{PCl}_5$			Phosphorus pentachloride
$\text{N}_2\text{O}_5$			Dinitrogen pentoxide

- Fill in the table to indicate the number of atoms of each type in the molecular formula.
- Examine the molecular formulas given in Model 1 for various molecular compounds.
  - How many different *elements* are present in each compound shown?
  - Do the compounds combine metals with metals, metals with nonmetals, or nonmetals with nonmetals?
  - Based on your answer to *b*, what type of bonding must be involved in molecular compounds?
- Find all of the compounds in Model 1 that have chlorine and fluorine in them. Explain why the name “chlorine fluoride” is not sufficient to identify a specific compound.
- Assuming that the name of the compound gives a clue to its molecular formula, predict how many atoms each of these prefixes indicates, and provide two examples.

mono-

di-

penta-

## Model 2 – Prefixes and Suffixes

Prefix	Numerical Value
mono-	
di-	
tri-	
tetra-	
penta-	
hexa-	
hepta-	
octa-	
nona-	
deca-	

Molecular Formula	Name of Compound
$\text{BCl}_3$	Boron trichloride
$\text{SF}_6$	Sulfur hexafluoride
$\text{IF}_7$	Iodine heptafluoride
$\text{NI}_3$	Nitrogen triiodide
$\text{N}_2\text{O}_4$	Dinitrogen tetroxide
$\text{Cl}_2\text{O}$	Dichlorine monoxide
$\text{P}_4\text{O}_{10}$	Tetraphosphorus decoxide
$\text{B}_5\text{H}_9$	Pentaboron nonahydride
$\text{Br}_3\text{O}_8$	Tribromine octoxide
$\text{ClF}$	Chlorine monofluoride

- Examine the prefixes in Model 2. Fill in the numerical value that corresponds to each prefix.
- What suffix (ending) do all the compound names in Model 2 have in common?



- Carefully examine the names of the compounds in Model 2. When is a prefix NOT used in front of the name of an element?
- Consider the compound NO.
  - Which element, nitrogen or oxygen, would require a prefix in the molecule name? Explain your answer.

*b.* Name the molecule NO.



- Find two compounds in Model 2 that contain a subscript of “4” in their molecular formula.
  - List the formulas and names for the two compounds.
  - What is different about the spelling of the prefix meaning “four” in these two names?

10. Find two compounds in Model 2 that contain the prefix “mono-” in their names.
- List the formulas and names for the two compounds.
  - What is different about the spelling of the prefix meaning “one” in these two names?
11. Identify any remaining names of compounds in Model 2 where the prefixes that do not exactly match the spelling shown in the prefix table.
12. Use your answers to Questions 9–11 to write a guideline for how and when to modify a prefix name for a molecular compound. Come to a consensus within your group.
13. Would the guideline you wrote for Question 12 give you the correct name for  $\text{NI}_3$  as it is given in Model 2? If not, modify your guideline to include this example.
14. All of the compounds listed in Model 2 are binary molecular compounds. Compounds such as  $\text{CH}_3\text{OH}$  or  $\text{PF}_2\text{Cl}_3$  are not binary, and compounds such as  $\text{NaCl}$  or  $\text{CaCl}_2$  are not molecular. Propose a definition for “binary molecular compounds.”
-  15. Collaborate with your group members to write a list of rules for recognizing and naming binary molecular compounds from their chemical formulas.



16. For each of the following compounds, indicate whether or not your naming rules from Question 15 will apply. If not, explain why the naming rules do not apply.



17. Using the rules your group developed in Question 15, name each of the following molecular compounds.

Molecular Formula	Molecule Name
$\text{PBr}_3$	
$\text{SCl}_4$	
$\text{N}_2\text{F}_2$	
$\text{SO}_3$	
$\text{BrF}$	

18. Write molecular formulas for the following compounds.

Molecular Formula	Molecule Name
	Disulfur decafluoride
	Carbon tetrachloride
	Oxygen difluoride
	Dinitrogen trioxide
	Tetraphosphorus heptasulfide



## Extension Questions

19. This activity focused on molecular (covalent) compounds, while an earlier activity addressed ionic compounds. Notice that the formulas for both types of compounds can look very similar, even though their names are quite different:

Chemical Formula	Type of Compound/Bonding	Compound Name
MgF <sub>2</sub>	Ionic	Magnesium fluoride
CuF <sub>2</sub>	Ionic	Copper(II) fluoride
SF <sub>2</sub>	Molecular (covalent)	Sulfur difluoride
NaBr	Ionic	Sodium bromide
AuBr	Ionic	Gold(I) bromide
IBr	Molecular (covalent)	Iodine monobromide

Identify two differences between the names or formulas for ionic compounds versus those for binary molecular compounds. Also identify two similarities.

	Names and Formulas of Ionic Compounds	Names and Formula of Molecular (Covalent) Compounds
Differences		
Similarities		

20. Use complete sentences to explain why AlCl<sub>3</sub> is called “aluminum chloride” (no prefix required), but BCl<sub>3</sub> is called “boron trichloride.”

21. In the table below, first identify the type of bonding present in each compounds. Then fill in the missing name or formula for each compound using the appropriate set of rules.

Chemical Formula	Type of Compound/Bonding	Compound Name
CS <sub>2</sub>		
PbI <sub>2</sub>		
BaCl <sub>2</sub>		
Se <sub>2</sub> S <sub>6</sub>		
		Xenon tetrafluoride
		Sodium phosphide
		Dinitrogen pentoxide
		Cobalt(III) bromide