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How do we name molecules?

Why are we doing this?

Atoms are the fundamental building blocks of all substances. The periodic table is a useful tool that we will use as a reference throughout this class when we need information about various atoms. In addition to using the periodic table, we will also refer to chemical substances by their names. Some substances have common names like water. However, this kind of name doesn't tell us much about the composition of this substance. Instead, we will use other molecular names like carbon dioxide because they describe more information about the types and number of atoms from which the substance is made. Using the correct chemical name for a substance is extremely important. Consider that carbon monoxide and carbon dioxide have very similar sounding names. However, carbon monoxide is a poisonous, deadly gas, while carbon dioxide is a greenhouse gas that we exhale when we breathe. The right name could be a matter of life or death.

Your Learning Outcomes

You will be able to:

- 1. Use the periodic table to identify the chemical symbol and name of an element.
- 2. Identify the name of a molecular compound based on its chemical formula.
- 3. Describe the atomic composition of a molecular compound based on its name.

The Plan

- 1. Assign roles*.
 - *Manager* This person will keep the team on task and provide direction to the group. This person is responsible for uploading the group's work to Gradescope. <u>Make sure you make a note of everyone in the group. You must add everyone's name when submitting your answers to Gradescope.</u>
 - b. *Spokesperson* This person will represent the group be responsible for speaking for the group to the rest of the class.
 - c. *Recorder* This person will be responsible for recording the team's answers to the Critical Thinking Questions in an organized and coherent manner.
 - d. *Analyst* This person will be responsible for critical analysis of the team's work (i.e., the Devil's Advocate). This person should make sure everyone understands what is happening before the group moves forward.
- 2. Complete the Critical Thinking Questions as a group.
 - a. If you have additional time, begin working on the Exercises. The Exercises are optional and not part of the required work.
- 3. Submit your team's work via Gradescope. Groups may choose to work in a Word document or write out their answers on a separate sheet of paper. All work must be upload to Gradescope as a PDF file.

*Students may choose to complete this activity independently, in which case, the student must perform all roles and complete all aspect of the activity.



**A* detailed periodic table can be found at the end of this activity. You can also find use the interactive periodic table found at <u>www.ptable.com</u>.

Information:

The periodic table can be organized into two main types of atoms: metal and nonmetals. Metals tend to all have very similar properties. They tend to be solids at room temperature; they are good conductors of heat and electricity; and they can be shaped into sheets and wires. Similarly, nonmetals tend to all have very similar properties as well. These properties, however, tend to be quite different from those of the metals. Nonmetals tend to be gases at room temperature and are not good conductors of heat or electricity.

Critical Thinking Questions

- 1. Where on the periodic table would you generally find the metals? On the left side (this is most of the elements)
- 2. Where would you generally find the nonmetals? On the right side

Model 2: The Floating Hydrogen

Hydrogen is the first element on the periodic table (in the upper left-hand corner). However, sometimes, chemists will show hydrogen as not connected to the first column or will move it to the right side of the periodic table as shown to the right.



Critical Thinking Question

3. Why might a chemist think of hydrogen as being on the right side of periodic table rather than on the left side?

Hydrogen is a nonmetal, so sometimes it is grouped with all of the other nonmetals.

Model 3: Molecular Compounds

Molecular Formula	Number of Atoms of	Number of Atoms of	Name of the Compound
	the First Element	the Second Element	
ClF	1	1	Chlorine monofluoride
ClF ₅	1	5	Chlorine pentafluoride
CO	1	1	Carbon monoxide
CO ₂	1	2	Carbon dioxide
Cl ₂ O	2	1	Dichlorine monoxide
PCl ₅	1	5	Phosphorus pentachloride
N_2O_5	2	5	Dinitrogen pentoxide

Critical Thinking Questions

- 4. Complete the table in Model 3 to indicate the number of atoms of each type in the molecular formula.
- 5. Examine the molecular formulas given in Model 3.
 - a. How many different elements are present in each compound shown? Each of the molecules in Model 3 contains two different elements.
 - b. Do the molecular compounds contain metals with metals, metals with nonmetals, or nonmetals with nonmetals? Nonmetals with nonmetals
- 6. Find all of the compounds in Model 3 that have chlorine and fluorine in them. Explain why the name "chlorine fluoride" is not sufficient to identify a specific compound. CIF, chlorine monofluoride, and CIF₅, chlorine pentafluoride, both contain only chlorine and fluorine. If we used the name chlorine fluoride, we would know to which of these compounds we were referring.
- 7. 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 from Model 3.

mono-	1	CF	chlorine monofluorine
di-	2	CO ₂	carbon dioxide
penta-	5	PC1 ₅	phosphorus pentachloride

Model 4: Prefixes and Suffixes

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

Molecular Formula	Name of Compound
BCl ₃	Boron trichloride
SF ₆	Sulfur hexafluoride
IF ₇	Iodine heptafluoride
NI ₃	Nitrogen triiodide
N_2O_4	Dinitrogen tetroxide
Cl ₂ O	Dichlorine monoxide
P_4O_{10}	Tetraphosphorus decoxide
B_5H_9	Pentaboron nonahydride
Br ₃ O ₈	Tribromine octoxide
ClF	Chlorine monofluoride
ClF	Chlorine monofluoride

Critical Thinking Questions

- 8. Examine the prefixes in Model 4. Complete the numerical value that corresponds to each prefix.
- 9. What suffix (ending) do all of the compound names in Models 3 and 4 have in common? "-ide"
- 10. Carefully examine the names of the compounds in Models 3 and 4. When is a prefix NOT used in front of the name of an element? The prefix mono- is not used on the first element (but is on the second).
- 11. Consider the compound NO.
 - a. Which element, nitrogen or oxygen, would require a prefix in the name of the molecule? Oxygen
 - b. Name the molecule NO. Nitrogen monoxide
- 12. Find two compounds in Model 4 that contain a subscript of "4" in their molecular formula.
 - a. List the formulas and names for the two compounds.
 - N_2O_4 dinitrogen tetroxide P_4O_{10} – tetraphosphorus decoxide
 - b. What is different about the spelling of the prefix meaning "four" in these two names? The "a" in "tetra-" is dropped when it is paired with oxide.

- 13. Find two compounds in Model 4 with the prefix "mono-" in their names.
 - a. List the formulas and names for the two compounds. Cl₂O – dichlorine monoxide
 - ClF chlorine monofluoride
 - b. What is different about the about the spelling of the prefix meaning "one" in these two names?

The "o" at the end of "mono-" is dropped when it is paired with oxide.

- 14. Use your answers to Questions 12 and 13 to write a guideline for how and when to modify the prefix name for a molecular compound. Come to a consensus within your group. When an element name begins with an "o", drop the vowel at the end of the prefix (for those that have them).
- 15. Would the guideline your created in Question 14 give you the correct name for NI₃ as it is given in Model 4? In not, modify your guideline to include this example. No. Only drop the "o" or "a" endings from the prefixes. Keep the "i" in "tri-". The compound is nitrogen triiodide (no dropped vowels).
- 16. All of the compounds listed in Model 4 are binary molecular compounds. Molecular compounds such as CH₃OH or PF₂Cl₃ are not binary. Propose a definition of a "binary molecular compound." A compound made up of two types of nonmetals.
- 17. Collaborate with your group members to write a list of rules for recognizing and naming binary molecular compounds based on their chemical formulas.

-The compound on contains nonmetals.

-The compound only contains two types of nonmetal elements

-Use the element symbol in the molecular formula (and the periodic table) to name each element. -Use the subscript to determine the appropriate prefix.

-Do not use the prefix "mono-" for the first nonmetal (use all other prefixes as appropriate). -Remove the last vowel (o or a) of the prefix (if applicable) for any oxides (i.e., when oxygen is the second element in the compound.

18. Water is a binary molecular compound with the chemical formula H₂O. Using the rules you came up with in Question 17, what would be the molecular name of H₂O? Dihydrogen monoxide

19. Name each of the following compounds.

Molecular Formula	Molecular Name
PBr ₃	Phosphorus tribromide
SCl ₄	Sulfur tetrachloride
N_2F_2	Dinitrogen difluoride
SO ₃	Sulfur trioxide
BrF	Bromine monofluroide

20. Write the molecular formula for the following compounds.

Molecular Formula	Molecular Name	
S_2F_{10}	Disulfur decafluoride	
CCl ₄	Carbon tetrachloride	
OF ₂	Oxygen difluoride	
N_2O_3	Dinitrogen trioxide	
P_4S_7	Tetraphosphorus heptasulfide	