

(Effective Alternative Secondary Education)

CHEMISTRY



MODULE 12 Chemical Nomenclature



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DEPARTMENT

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Module 12 Chemícal Nomenclature



What's in a name?

It is not known when humans first began using names though the practice is certainly very old, probably extending far into prehistory. Although all cultures use names, naming customs vary greatly from people to people.

Names serve several purposes. Most importantly, they help us distinguish people from one another. Imagine how difficult it would be to refer to people if we did not use names. Instead of saying *Bob* one would have to say something like *the short red-headed man who lives down the street*. Some names carry information about our roots, such as family or clan names. They are generally inherited. Names can serve other purposes as well, such as the Chinese generation name which identifies the generation of the bearer, or the names used by some African cultures which describe the order in which siblings were born.

Like human beings, compounds also have names. *Chemical nomenclature* is the term given to the naming of compounds. It is used to identify a chemical species by means of written or spoken words. It is a useful means for *communication* among chemists. The name of the compound contains within itself an implied relationship to the structure of the compound. This helps the reader or listener deduce the structure (and thus the identity) of the compound. But this purpose requires a system of principles and rules, the application of which gives rise to a *systematic nomenclature*.

This module on chemical nomenclature contains these lessons:

- Lesson 1 Chemical Symbol
- Lesson 2 Chemical Formula
- Lesson 3 Empirical Formula and Molecular Formula



After going through this module, you are expected to:

- 1. Trace the historical background of chemical symbols.
- 2. Identify and memorize the symbols of common elements.
- 3. Recall and apply the rules in writing and naming different compounds.
- 4. Differentiate between empirical and molecular formulas.
- 5. Determine the empirical and molecular formulas of compounds.



How to learn from this module

Here is a simple guide for you in going about this module.

- 1. Read and follow instructions very carefully.
- 2. Take the 10-item multiple choice test provided at the start of this module to determine how much you know about the lesson in this module
- 3. Check your answers against the key to answers provided at the last page of the module
- 4. Perform all the activities provided in each lesson as these will help you have a better understanding of the topic.
- 5. Take the self-tests at the end of each lesson for you to determine how much you learned.
- 6. Take the 10-item multiple–choice test at the end of the module.

Good luck and have fun!



What to do before (Pretest)

I. Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following is a binary ionic compound?

a.	CO ₂	•	-	C.	CaCl ₂
b.	CCI ₄			d.	CaCO ₃

2. Which compound is commonly called laughing gas?

a.	N ₂ O	 C.	N_2O_3
b.	NO ₂	d.	NO_{3}^{-1}

3.	Which of the following substances is used hyperacidity? a. MgCO ₃ b. MgCl ₂	to neutralize acid in the stomach that causes c. Mg(OH) ₂ d. MgO
4.	What is the common suffix used in naming a. ~ ate b. ~ ite	binary inorganic compounds? c. ~ ic d. ~ ide
5.	What polyatomic ion is commonly found in a. Acetate b. Bicarbonate	basic compounds? c. Cyanide d. Hydroxide
6.	Which of the following does NOT belong to a. Al ₂ O ₃ b. AlPO ₄	the group? c. AICI ₃ d. AIP
7.	What is the best way of naming C ₂ O ₄ ²⁻ ? a. Oxalate b. dicarbon tetroxide	c. carbon oxide d. carbon dioxide
8.	Which of the following is also known as hyd a. H ₂ S b. H ₂ SO ₃	drosulfuric acid? c. H ₂ SO ₄ d. H ₂ S ₂ O ₃
Fo	or numbers 9 to 10, refer to the following cho a CaSO₄	ices: c MaSQ₄

a.	$CaSO_4$	C.	$NIGSO_4$
b.	CuSO₄	d.	BaSO ₄

9. What compound is also known as gypsum?

10. What compound is also known as Epsom salt?

II. Matching Type. Match the term/discoverer in column B with its definition/discovery in column A. Write the letter of your choice on a separate sheet.

Column A	Column B
1. shorthand representation of elements	a. America
2. simplest formula	b. Argentina
3. the number written after the symbol of the	c. Covalent
element	d. Cuprum
4. English name for natrium	e. Empirical
5. shorthand representation of compounds	f. Ferrum
6. the inventor of the element oxygen	g. Formula
7. the country where the element silver	h. H ₂ O
originated from	i. H ₂ O ₂
8. the Latin name of the element iron	j. lonic
9. a type of compound composed of metallic	k. Lavoisier
and nonmetallic elements	I. Molecular
10. the molecular formula of the compound	m. Priestly
aqua oxigenada	n. Sodium
	o. Subscript
	p. Symbols



Key to answers on page 17.

Lesson 1. Chemical Symbol

There are 114 known elements at present. Ninety-two of these are found in nature and the others are produced in the laboratory. Among the 114 elements, 11 are known to be gases. Some of these are oxygen, hydrogen, nitrogen, chlorine, and helium. Elements like neon, argon, krypton, xenon, radon, and fluorine are very rare and are not found in large quantities in nature. All the rest are solids.

Now, each element has been given a name and a symbol. It was not always like this. Before the year 1814, the chemical symbols were expressed this way:

Element	Symbol
Iron	ੱ ਹੈ
Copper	Ŷ
Gold	0

Then Jon Jacob Berzelius (1779-1848), a Swedish chemist, started to use chemical symbols. He used the initial letter of the element's Latin or common name in its capitalized form as its chemical symbols as follows:

C = carbon O = oxygen I = iodine

This practice is still followed today. If the two elements start with the same letter, two letters are used as in the following:

Ca = calcium Co = cobalt

The symbols of other elements are related to their Latin names like the following:

Elements	Latin name	Symbol	Elements	Latin name	Symbol
Antimony	Stibium	Sb	Lead	Plumbum	Pb
Copper	Cuprum	Cu	Potassium	Kalium	K
Gold	Aurum	Au	Silver	Argentum	Ag
Iron	Ferrum	Fe	Sodium	Natrium	Na
Mercury	Hydrargyrum	Hg	Tin	Stannum	Sn

What do you think is the symbol for each of the following elements?

- a. hydrogen
- b. helium
- c. boron
- d. barium

The table below could help you memorize the symbols of some common elements, their discovery and their Latin name, if there is.

Name	Date	Discoverer	Latin Name	Symbol
Carbon	antiquity	Unknown	None	С
Gold	antiquity	Unknown	Aurum	Au
Silver	antiquity	Unknown	Argentum	Ag
Copper	antiquity	Unknown	Cuprum	Cu
Sulfur	antiquity	Unknown	None	S
Tin	antiquity	Unknown	Stannum	Sn
Lead	antiquity	Unknown	Plumbum	Pb
Mercury	antiquity	Unknown	Hydrargyrum	Hg
Iron	antiquity	Unknown	Ferrum	Fe

Name	Date	Discoverer	Latin Name	Symbol
Arsenic	1250	Albertus Magnus is believed to have been the first to isolate the element.	None	As
Antimony	1450	First described scientifically by Tholden	Stibium	Sb
Bismuth	15th century?	May have been described in writings attributed to Basil Valentinus, definitively identified by Claude Geoffroy Junine in 1753	None	Bi
Zinc	1526	Identified as a unique metal by Paracelsus	None	Zn
Phosphorus	1669	Hening Brand, later described by Robert Boyle	None	Ρ
Cobalt	1732	Georg Brandt	None	Со
Platinum	ca. 1741	Discovered independently by Antonio de Ulloa (published 1748) and Charles Wood.	None	Pt
Nickel	1751	Axel Fredrik Cronstedt	None	Ni
Magnesium	1755	Joseph Black	None	Mg
Oxygen	1771	Joseph Priestley	None	0
Nitrogen	1772	Daniel Rutherford	None	N
Chlorine	1774	Carl Wilhelm Scheele	None Cl	
Manganese	1774	Johan Gottlieb Gahn	None	Mn
Hydrogen	1776	Isolated and described by Henry Cavendish, named by Antoine Lavoisier	None H	



Welcome to the Elemental - Element Crossword Puzzle!

Given at the right are the symbols of different elements. Complete the crossword puzzle by figuring out the elements that they represent.

Good luck and have fun!



	Easy
	Symbols
	Across
2.	He
3.	N
6.	С
9.	I
10.	U
	Down
1.	Li
4.	Ne
5.	Al
7.	Ar
8.	0





Multiple Choice. Choose the letter that corresponds to the best answer. Write your choice on a separate paper.

1. What is the correct symbol for cuprum?

a.	С	5	•	C.	Ср
b.	Cu			d.	Ċr

- 2. Which of the following does **NOT** belong to the group?
 - a. Argentum c. Calcium
 - b. Aurum d. Kalium
- 3. Which of the following elements is the youngest?
 - a. argon c. helium
 - b. carbon d. hydrogen
- 4. What is the English name of stibium?
 - a. antimony c. lead
 - b. arsenic d. tin
- 5. Which of the following does **NOT** belong to the group?
 - c. carbon
 - d. hydrogen

- c. nitrogen
- d. oxygen



If you scored 3 or more out of 5 -CONGRATULATIONS!

You may now proceed to the next lesson. If you scored below 3, you need to go back and read the lesson again!

Lesson 2. Chemical Formula

Chemical Formulas

Chemical formulas such as $MgSO_4$ can be divided into **empirical formula**, **molecular formula**, and **structural formula**. The chemical symbols of elements in the chemical formula represent the elements present in the compound. The subscript numbers represent mole proportions of the preceding elements. If no number is written, it means the subscript is 1.

The Writing of Formulas

Compounds formula can be written in several forms. In this area we will discuss how to write the formula of a simple **binary ionic compound** (compound composed of metal and a nonmetal) whose name is known. The metal acts the *cation* (positively-charged ion) while the nonmetal forms the *anion* (negatively-charged ion). The first part of the name of an inorganic compound is the first part of the formula.

Formula Writing of Binary Ionic compounds

Charge – Crossing Technique

Rules to follow:

- The total positive charges must equal the total negative charges. •
- Do not change the charges given to you.
- Adjust the subscripts to equalize the charges.

Write down the Na⁺ and Cl⁻ right next to each other, as in this image:

Suppose you want to write the formula for the common table salt, sodium chloride.

 $Na^{1+}Cl^{1-}$

Al 🖌

Al₂O3

2-ന

Move the positive charge (dropping the sign) to the subscript position of the Na¹⁺~ anion: Move the negative charge (dropping the sign) to the subscript position of the Na¹⁺ cation: Na₁Cl₁ The result is: Since subscripts of one are not written but are understood to be present, the NaCl final answer is: Write the formula for aluminum oxide. Al³⁺ 2-Write down the AI^{3+} and O^{2-} right next to each other: Ο Move the positive charge (dropping the sign) to the subscript position of the Al³⁺

Move the negative charge (dropping the sign) to the subscript position of the cation.

This results to:

anion:

What you will do Activity 2.1

Write the correct formula of the following compounds:

- 1. hydrogen chloride (you must know that this is the common muriatic acid for cleaning purposes)
- 2. calcium fluoride (do you still remember the anti tartar ingredient of your toothpaste?)
- 3. sodium oxide (the substance behind the cleansing principle of your laundry detergent)



The Naming of Compounds: Nomenclature

Identifying a Compound as Ionic or Molecular

In naming compounds, you have to decide first whether you are looking at an ionic compound or a molecular compound. We know that metals combined with nonmetals will produce compounds that are **ionic**. Nonmetals combined with nonmetals will produce compounds that are **molecular**.

For example: MgCl₂ would be ionic because it has the chloride ion which is a nonmetal combined with magnesium which is a metal. Metals combined with nonmetals produce ionic compounds.

Nomenclature of Binary Ionic Compounds

A binary compound is made up of two different elements. There can be one of each element such as in NaCl or KF. There can also be several of each element such as Na_2O or $AlBr_3$.

Please remember that all elements involved in this lesson have **ONLY ONE** charge.

Points to remember about naming a compound from its formula

- 1. The order for names in a binary compound is first the cation, then the anion.
- 2. Use the name of cation directly from the periodic table.
- 3. The name of the anion will be made from the root of the element's name plus the suffix "-ide."

Example: Write the name of this formula: H₂S

Steps		Results
1	Look at the first element and name it	Hydrogen
2	Look at second element. Use the root of its full name (which is sulf-) plus the ending "-ide "	sulfide

These two steps give the full name of H_2S . Notice that the presence of the subscript is ignored.

Nomenclature of Acids and Bases

For the purposes of naming acids and bases, we will classify these chemicals into three categories: binary acids, ternary acids (sometimes called oxy-acids), and bases.

Binary Acids

Binary acids contain hydrogen and one other nonmetallic element. Their names follow the pattern of "**hydroelementic acid**" where **element** is replaced by the root of the name of the element. These acids contain no oxygen. Here are some examples.

HF	hydrofluoric acid
H ₂ S	hydrosulfuric acid
HBr	hydrobromic acid

Note that the names of binary acids do not indicate how many hydrogen atoms are in the formula. That is determined by the valence of the other element.

Bases

Bases are simply named as ionic compounds containing the hydroxide ion. Here are some examples.

NaOH	sodium hydroxide	
Ca(OH) ₂	calcium hydroxide	
Fe(OH) ₃ iron(III) hydroxide		
	ferric hydroxide	
NH₄OH	ammonium hydroxide	



Try answering the following exercises:

Matching type. In Part A, match the name of the compound in column A with its formula in column B. In Part B, match the formula of the compound in column A with its name in column B.

Column A	Column B		
A. Formula Writing			
1. Sodium Bromide	a. AlBr ₃		
2. Barium Phosphide	b. AICI		
3. Calcium Oxide	c. Ba₃P₂		
4. Lithium Sulfide	d. CaO		
5. Aluminum bromide	e. L ₂ S		
	f. NaBr		
B. Naming			
1. Mgl ₂	a. Barium sulfide		
2. K ₂ O	b. Hydrogen fluoride		
3. LiCl	c. Hydrogen chloride		
4. BaS	d. Magnesium iodide		
5. HF	e. Lithium chloride		
	f. Potassium oxide		

Key to answers on page 18.

Before going to the next lesson, try answering the following:



Multiple Choice. Choose the letter that corresponds to the best answer. Write your choice on a separate paper.

1. Which of the following formulas is an acid?

a.	Na ₂ CO ₃	c. H₂O
b.	NaOH	d. HCI

2. Which of the following is the correct formula for magnesium chloride?

a.	MgCl ₂	c. MgCO ₃

b. Mg_2CO_3 d. $Mg(CO_3)_2$

3. Which of the following represents the correct name for BaO?

- a. Barium oxide c. Beryllium oxide
- b. Boron oxide d. none of the above
- 4. Which does **NOT** belong to the group?
 - a. HclO c. HF b. HCl d. H_3N

5. What is the correct formula formed if AI^{+3} is combined with S^{-2} ?

- a. AI_3S_2
- b. AI_2S_3

c. Al^2S^3

d. None of the above



If you scored 3 or more out of 5 – CONGRATULATIONS!

You may now proceed to the next lesson. If you scored below 3, you need to go back and read the lesson again!

Lesson 3. Empirical and Molecular Formula

Empirical (Simplest) formula is a formula whose subscripts represent the simplest whole number ratio of atoms in a molecule or the simplest whole number ratio of moles of each element in a mole of the compound. The simplest formula is usually determined by considering experimental data, hence the name "empirical" which means based on experimentation. It speaks of relative numbers. For example, CH₂ says that there will be twice as many hydrogens as there are carbons in the compound that has this simplest formula. It does not give the exact numbers of hydrogens and carbons in the compound.

On the other hand, **molecular formula** gives the exact number of atoms of each element per molecule of the compound or the absolute number of moles of each element per mole of the compound. A molecular formula may be reducible to a simple formula if all its subscripts are divisible by a common denominator.

Some compounds have the same empirical and molecular formula. For example, carbon dioxide has CO_2 as its empirical and molecular formula. The empirical and molecular formula for sulfur dioxide is also the same: SO_2 .

There are many situations where two or more compounds have the same simplest formula but different molecular formulas. For example, benzene and acetylene have the same simplest formula, CH. However, benzene's molecular formula is C_6H_6 and acetylene's molecular formulas is C_2H_2 . The table below shows examples of the empirical and molecular formula of certain compounds.

Compound	Molecular Formula	Empirical Formula
Water	H ₂ O	H ₂ O
Hydrogen Peroxide	H ₂ O ₂	НО
Sodium phosphide	Na₃P	Na₃P
Magnesium sulfide	Mg ₂ S ₂	MgS

Table 1. Comparing Empirical and Molecular Formulas

To determine the molecular formula of the compound, just follow these steps:

- 1. Find the mass of the empirical unit.
- 2. Figure out how many empirical units are in a molecular unit.
- 3. Write the molecular formula.

Example: A compound with an empirical formula of CH has a molar mass of 78. What is its molecular formula?

Answer:

Step #1. C : $12 \times 1 = 12$ H : $1 \times 1 = 1$ 13Step #2. 78/13 = 6 Step #3. (CH)₆ = C₆H₆

On the other hand, if the empirical formula is asked, simply divide the subscripts of the molecular formula with the greatest common factor. The resulting SIMPLEST WHOLE NUMBER represents the subscript in the empirical formula.

Example: What is the empirical formula of the compound Na₂C₂O₄?

Answer: Just divide the subscripts of the molecular formula by the greatest common factor. The resulting empirical formula is **NaCO**₂.



What you will do Activity 3.1

Try to fill in the table with the empirical or molecular formula of the compound.

Molar mass	Molecular formula	Empirical mass	Empirical formula
	C ₁₂ H ₂₂ O ₁₁ (table sugar)	342	
34			HO
	C ₆ H ₁₂ O ₆		CH ₂ O





Direction: Write A if the given formula of the compound is empirical. Write B if it is a molecular formula. Write your choice on a separate paper.

- 1. BaSO₄
- 2. KMnO₄
- 3. Sn₂O₄
- 4. Al₃P₃
- 5. PbS₂



If you scored 3 or more out of 5 – CONGRATULATIONS!

We have come to the end of the module. If you scored below 3, you need to go back and read the lesson again!



- 1. The symbols of the elements that we are using at present evolved from the ideas presented by Lavoisier, Dalton and Berzelius. They are patterned after Berzelius' concept. The following are the rules that Berzelius employed in his system of writing chemical symbols:
 - a. In metalloids, use the initial letter only, even when this letter is common to the metalloid and some metal.
 - b. In metals, distinguish those that have the same initials with another metal, or a metalloid, by writing the first two letters of the word.
 - c. If the first two letters are common to two metals, in that case, add to the initial letter the first consonant which they do not have in common: for example, S = sulphur, Si = silicon, St = stibium (antimony), Sn = stannum (tin), C = carbon, Co = cobaltum (cobalt), Cu = cuprum (copper), O = oxygen, Os = osmium.
- 2. A chemical formula (also called molecular formula) is a concise way of expressing information about the <u>atoms</u> that constitute a particular <u>chemical compound</u>. It identifies each type of <u>element</u> by its <u>chemical symbol</u> and identifies the number of atoms of such element to be found in each discrete <u>molecule</u> of that compound. The number of atoms (if greater than one) is indicated as a <u>subscript</u>. For nonmolecular substances the subscripts indicate the ratio of elements in the empirical formula.

- 3. The formula could be empirical, molecular or structural.
- 4. There are different systems by which a compound's formula could be written or named. The choice of system is based on whether the compound is binary, ionic or covalent, ternary, or acids or bases.
- 5. The compound's empirical and molecular formulas can be determined using these steps:
 - a. Empirical formula determination
 - Divide each subscript of the molecular formula by the greatest common factor.
 - The resulting SIMPLEST WHOLE NUMBER represents the subscript in the empirical formula.
 - b. Molecular formula determination
 - Find the mass of the empirical unit.
 - Figure out how many empirical units are in a molecular unit.
 - Write the molecular formula.



Multiple Choice. Choose the letter that corresponds to the best answer. Write your choice on a separate paper.

- 1. What is a chemical compound?
 - a. The combination of elements.
 - b. The combination of two or more different elements.
 - c. The combination of two or more similar elements.
- How many atoms of oxygen are in the formula H₂SO₄?
 a. 2
 b. 4
 c. 8
- 3. How many atoms of oxygen are in the formula C₃H₅(NO₃)₃?
 b. 3
 b. 6
 c. 9
- 4. What is the correct formula of calcium sulfide?
 a. CaS₄
 b. Ca₂S₂
 c. CaS
- 5. The algebraic sum of all the oxidation numbers of elements in a compound is a. 2 b. 1 c. 0
- 6. Alkali metals have an oxidation number of a. +1 b. +2 c. -1

- Caffeine, a primary stimulant in coffee and tea, has a molecular formula of C₈H₁₀N₄O₂. Which of the following represents its empirical formula?
 a. C₂H₅N₂O
 b. C₄H₅N₂O
 c. C₈H₁₀N₄O₂
- 8. What is the empirical formula of a compound that contains K₂C₂O₄?
 a. K₂CO₃
 b. KCO₂
 c. K(CO₃)₂
- 9. What is the molecular formula of the compound with an empirical formula of CH₂, and molar mass = 84 g/mol?
 - a. C_3H_6 b. C_6H_{12} c. C_9H_{18}
- 10. What is the molecular formulas of Ibuprofen if its empirical formula is (C₇H₉O) and its mass is 109 with a molar mass of 218 g/mol?
 - a. $C_{13}H_{18}O_2$ b. $C_{12}H_{18}O_2$ c. $C_{14}H_{18}O_2$



If you scored 7 or more out of 10 – Congratulations! You may now proceed. If you scored below 7, you need to go back and read the module again!



Pretest

I.		II.	
1. c	6. a	1. p	6. m
2. а	7. a	2. e	7. b
3. c	8. a	3. o	8. f
4. d	9. a	4. n	9. j
5. d	10. c	5. g	10. i

Lesson 1

Activity 1.1

Acı	'OSS	Down
2.	helium	1. lithium
3.	nitrogen	4. neon
6.	carbon	5. aluminum
9.	iodine	7. argon
10.	uranium	8. oxygen

Self-Test 1.1

- 1. c
 - 2. c
- 3. d
- 4. a
- 5. a

Lesson 2

Activity 2.1

- 1. HCI
- $2. \ CaF_2$
- 3. Na₂O

Activity 2.2

Self-Test 2.1

Α	В	
1. f	1. d	1. d
2. c	2. f	2. a
3. d	3. e	3. а
4. e	4. a	4. a
5. a	5. b	5. a

Lesson 3

Activity 3.1

Molar mass	Molecular formula	Empirical mass	Empirical formula
342	C ₁₂ H ₂₂ O ₁₁ (table sugar)	342	$C_{12}H_{22}O_{11}$
34	H_2O_2	17	НО
180	C ₆ H ₁₂ O ₆	30	CH ₂ O

Self-Test 3.1

- 1. a
- 2. a
- 3. b
- 4. b
- 5. a

Posttest

1.	b	6.	а
2.	b	7.	b
3.	С	8.	b
4.	С	9.	b
5.	С	10.	С

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