Learning Guide

Subject Code	Chem 1	General Inorganic Chemistry
Module Code	2.0	Chemical Reactions and Stoichiometry
Lesson Code	2.1.2	Writing and Naming Chemical Formulas Part 2
Time Limit		30 min

Components	Tasks	AT[a]	ATA[b]
Target	By the end of the chapter, the students must be able to name and write chemical formulas.	1 min	
Hook	What is in a name? People from all walks of science use a precise system for naming every matter, living or not, on earth; but why and to what end? Nomenclature came from the Latin words *nomen* (name) and *calare* (to call) (Silberberg, 2015). In Biology, we are quite familiar on how they use scientific names in their extensive collections of plant and animal specimens around the world. Many people see the problem with common names given to plants and animals. These names tend to differ from country to country. Take this as an example: An entire research team was devoted on the study of European fire salamander. In Germany, it is known as the *Feuersalamander*. This amphibian is branded as *Lekeli Semender* in Turkey. In Greece, the Σαλαμάνδρα, a word which is mouthful to pronounce if you're not a speaker of the native language. If many names will be used, there is a tendency that scientific research may be restricted for data will be easily missed. A *binomial name* (system used to name species) brings organization to irregularity, and order to the literature, by assigning a single name that will be used by every researcher (Burgon, 2015).  **Fig. 1.** Winter, Herwig. *Feuersalamander* [photograph]. (n.d.). Retrieved July 28, 2020 from BUND Hessen. Same is true with Chemistry. There is a little bit of similarity between the respects of Chemistry and foreign languages. One of the many reasons why people find Chemistry as a system of communication is because of the orthography – the systematic way it is written which involves the study of correct spelling, how letters are arranged, and the way letters and diacritic symbols represent the sounds of a language in spelling.	5 min	

	In chemical language, it is logically true that it is essential to learn the chemical alphabet – the periodic table. By knowing the alphabet, the students are now equipped with the basics to form chemical words. The chemical language gets more complex when two or more elements get involved. As a language, the students can put together words to give rise to chemical formulas and reactions from predetermined constituents. Chemical nomenclature assures certainty to every written or spoken chemical name that it refers to a single substance. It is necessary that each compound has a unique name, recognized and can be understood by everyone. **Table 1.** Common and Trade Names of Chemicals **Common Name** / **Chemical Name** / **Formula** Alcohol, wood / Methanol, methyl alcohol / CH_3OH Alcohol, grain / Ethanol, ethyl alcohol / CH_3CH_2OH Battery acid / Sulfuric acid / H_2SO_4 Bleach / Sodium hypochlorite / NaClO Chloroform / Trichloromethane / $CHCl_3$ Lime / Calcium oxide / CaO Limestone / Calcium carbonate / $CaCO_2$ Muriatic acid / Hydrochloric acid / HCl Slaked lime / Calcium hydroxide / $Ca(OH)_2$ Upon knowing the importance of naming chemical compounds systematically, you are now ready to proceed with this topic.		
Ignite	**<u>Binary Compounds Containing Two Nonmetals</u>** When two nonmetals are being combined, binary covalent compounds are typically formed. Common names are usually used and we are familiar to some, such as water (H_2O), methane (CH_4), and ammonia (NH_4). These compounds can be named systematically: 1. The elements involved must be placed in their proper orders. The element to be named first is usually the one located on the farthest to the left in the periodic table. In some cases, both elements can be found in the same group. The element found at the lowest part of the column will be named first. Treat the second element as if it was a monoatomic ion, just like that in an ionic compound, even though it is not. Use the suffix *-ide* to the root of the element name. 2. The number of each type of atom present in the compound must be identified. Shown in Table 2 the prefixes originating from Greek stems. These are being used to indicate the number of each distinct atom included in the formula unit.	15 min	

To avoid confusion, the prefix *mono-* for "one" is only used when necessary, similar to the subscript 1 that is being omitted when writing formulas.

Table 2. Greek Prefixes

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

Hydrogen is located to the left of chlorine in the periodic table, so HCl is named as hydrogen chloride. Following this line of thought, phosphorus pentachloride has a chemical formula of PCl_5.

BrF_3 is named as bromine trifluoride, because bromine lies below fluorine in Group 17.

There are times when a compound contains more than one atom of both elements. For example, N_2O_3 is dinitrogen trioxide. Take note that prefixes are used for the two nonmetals.

In some names, the last vowels of the prefixes ending in "a" and "o" are dropped to avoid awkward pronunciation. With this, OsO_4 is pronounced as osmium tetroxide instead of osmium tetraoxide.

3. Write the name of the compound.

Oxygen forms binary compounds with other elements and they are named as "element oxide". Prefixes are still being used to indicate the number of atoms present per formula unit. We have CO, carbon monoxide, as an example.

Common names are often used for certain compounds. These have come into play before formulas are being introduced. We don't say dihydrogen monoxide (H_2O) for water. Some examples include ammonia (NH_3), phosphine (PH_3), and silane (SiH_4).

Some compounds require familiarity to their systematic and common names. For instance, NO. Its systematic name is nitrogen monoxide, but it is commonly referred to as nitric oxide. In the same way, N_2O is known as nitrous oxide rather than dinitrogen monoxide.

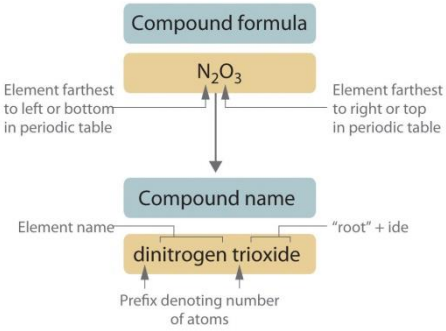

Fig. 2. *Naming a covalent inorganic compound* [graphic illustration]. (2020). Retrieved July 28, 2020 from Chemistry LibreTexts.

Examples:

Formula	Name
N_2O_4	Dinitrogen tetroxide*
PCl_5	Phosphorus pentachloride
SO_3	Sulfur trioxide
CS_2	Carbon disulfide
P_2O_5	Diphosphorus pentoxide*

Hydrates are ionic compounds that have a specific number of water molecules in each formula unit. A coefficient before H_2O indicates the number of water molecules in the formula. This will appear after a centered dot and be named using the previously discussed Greek numerical prefixes (Table 2) before the word *hydrate* (Silberberg, 2015).

Examples:

Formula	Name
$CuSO_4 \cdot 5H_2O$	Copper (II) sulfate pentahydrate
$NiSO_4 \cdot 6H_2O$	Nickel (II) sulfate hexahydrate
$Al(NO_3)_3 \cdot 5H_2O$	Aluminum nitrate nonahydrate

<u>Acid Names from Anion Names</u>

Since before the time of alchemists, people have been managing acids in chemical reactions. These are an important group of hydrogen-containing compounds that are typically used in water solution. We consider acids as anions that contain one or more hydrogen ions (H^+) to give a neutral compound. Binary acids and oxoacids are the two common types of acids:

1. When certain gaseous compounds dissolve in water, binary acids solutions are formed. For example, hydrochloric acid is produced when gaseous hydrogen chloride (HCl) is dissolved in water. The acid is named this way:

   Prefix *hydro-* + nonmetal root + suffix *-ic* + acid
   hydro + chloric + acid

   This naming pattern is being followed by many compounds in which hydrogen combines with an anion that bears the *-ide* suffix.

Examples:

Anion	Formula of Acid	Compound Name (as a gas)	Acid Name (aqueous form)
F^-	HF	Hydrogen fluoride	Hydrofluoric acid
Br^-	HBr	Hydrogen bromide	Hydrobromic acid
I^-	HI	Hydrogen iodide	Hydroidic acid
S^{2-}	H_2S	Hydrogen sulfide	Hydrosulfuric acid

2. There is a similarity between the names of oxoacids and oxoanions, but one must take note of these two suffix changes:
    - *-ate* in the anion becomes *-ic* in the acid
    - *-ite* in the anion becomes *-ous* in the acid

    BrO_4^- is perbromate, and $HBrO_4$ is perbromic acid. IO_2^- is iodite, and HIO_2 is iodous acid. Take note that the oxoanion prefixes *hypo-* and *per-* are retained (Silberberg, 2015).

Examples:

Anion	Name of Anion	Formula of Acid	Name of Acid
$C_2H_3O_2^-$	Acetate	$HC_2H_3O_2$	Acetic Acid
CO_3^{2-}	Carbonate	H_2CO_3	Carbonic Acid
NO_2^-	Nitrite	HNO_2	Nitrous Acid
NO_3^-	Nitrate	HNO_3	Nitric Acid
PO_3^{3-}	Phosphite	H_3PO_3	Phosphorous Acid
PO_4^{3-}	Phosphate	H_3PO_4	Phosphoric Acid
IO_2^-	Iodite	HIO_2	Iodous Acid
IO_3^-	Iodate	HIO_3	Iodic Acid
IO_4^-	Periodate	HIO_4	Periodate Acid
$C_2O_4^{2-}$	Oxalate	$H_2C_2O_4$	Oxalic Acid

A number of chemicals are commonly found, staring blankly at you whenever you placed your gaze upon your cupboards and cabinets, at home. Mason jars, hollow bottles, paper boxes, and even tin cans are some of the containers that bear its identity for the end-user to easily identify its nature and uses. These typical household chemicals are intended particularly to assist general hygiene purposes, pest control, domestic cleaning, and sometimes in cooking. Take a look at the following products:

1. Hydrogen peroxide (H_2O_2) or agua oxigenada is a colorless viscous unstable liquid that readily decomposes in water and oxygen. This compound commonly appears as a mild antiseptic, color-removing substance, component in rocket fuel and a disinfectant.
2. Acetic acid ($HC_2H_3O_2$) or vinegar is used as a preservative and a condiment.
3. Hydrochloric acid (HCl) or muriatic acid is used for cleaning and other industrial processes.
4. Carbonic acid (H_2CO_3) or carbon dioxide solution is the one responsible for the fizzing in carbonated drinks.
5. Sulfuric acid (H_2SO_4), also known as battery acid or oil of vitrol, is an exceptional pick for products such as toilet bowl

	cleaners and drain cleaners or openers. It may also be used in powdered laundry detergents, manufacture of fertilizers, hand soaps, dyes, dishwashing liquids, pet products, and explosives. How to Speak Chemistrian: Naming Chemical Compounds Watch https://youtu.be/mlRhLicNo8Q		
Navigate	**CHEM-MUST-TRY!** **I.** Write the formula for each of the following compounds. 1. Sulfur hexafluoride 2. Dinitrogen tetroxide 3. Chlorine dioxide 4. Iodine heptafluoride 5. Dinitrogen pentoxide 6. Cobalt (II) chloride hexahydrate 7. Iron (III) hydrate tetraphosphate 8. Sodium carbonate decahydrate 9. Hydroiodic acid 10. Sulfurous acid **II.** Name the following compounds. 1. $HI_{(g)}$ 2. Cl_2O_7 3. $Ca(ClO_2)_2 \cdot 3H_2O$ 4. $HBrO_3$ 5. N_2O_3 **Additional Assessment:** **I.** Name each of the following anions and give the name and the formula of the acid derived from it. Example: Br^- bromide; hydrobromic acid, HBr. 1. F^- 2. IO_3^- 3. CN^- 4. SO_4^{2-} 5. NO_2^- **II.** Write the formula for the name or name for the formula of the following compounds: 1. nickel (II) nitrate hexahydrate 2. zinc sulfate heptahydrate 3. $FeO_3 \cdot 3H_2O$ 4. I_2O_5 5. S_2F_{10} 6. SeF_6 7. N_2O 8. phosphorus pentachloride 9. $HClO_3$ 10. H_2SO_3	8 min	
Knot	**SUMMARY:** • In naming binary covalent compounds, the element with the lower group number in the periodic table comes first in the	1 min	

name. The element with the higher group number comes second and is named with its root and the suffix *-ide*. If both elements are in the same group, the one with the higher period number is named first (Mendoza and Religioso, 2001).

- Greek numerical prefixes are used to indicate the number of atoms of each element in a covalent compound. The second element usually has a prefix, but when more than one atom is present, the first element will make use of the prefix.
- Names of hydrates have a numerical prefix indicating the number of associated water molecules.
- Acids are named as follows:

Ending	Anion Change	Anion Example	Acid Name
-ide	Add *hydro-* and change ending to *-ic*	chlor*ide*	Hydrochloric acid
-ite	Change ending to *-ous*	chlor*ite*	Chlorous acid
-ate	Change ending to *-ic*	chlor*ate*	Chloric acid

[a] suggested time allocation set by the teacher
[b] actual time spent by the student (for information purposes only)

References:

Albarico, J. (PSHS-CBRZ). (n.d.). THINK Framework. Based on Science Links by E.G. Ramos and N. Apolinario, Quezon City. Rex Bookstore.

Bayquen, A. (2012). *Chemistry, Exploring Life Through Science*. (G. Bernas PhD, Coordinator.) 2nd Edition. Quezon City, Philippines: Phoenix Publishing House.

Burgon, J. (2015). *The Importance of Names*. Retrieved July 30, 2020 from Naturally Speaking.

Mendoza, E., Religioso T. (2001). *You and the Natural World Series, Third Year Chemistry Textbook.* (M. Deauna, Coordinator.) 2nd Edition. Quezon City, Philippines: Phoenix Publishing House.

Names and Formulas of Inorganic Compounds. (2020). Retrieved July 29, 2020 from Chemistry LibreTexts.

Silberberg M. (2015). *Chemistry: The Molecular Nature of Matter and Change*. 7th Edition. New York, USA: McGraw-Hill Education.

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