

**Nomenclature
Naming Ionic Compounds
Worksheet #1**

In forming ionic compounds with non-metals, the transition metals *often* exhibit more than one valence. For example, in the reaction between iron and chlorine, two products are possible because iron can form an Fe^{3+} ion and an Fe^{2+} ion. The products are FeCl_3 and FeCl_2 .

Some periodic tables list the different possible charges for multi-valent transition metals with the most common charge listed first.

Example 1:

Copper is a multi-valent transition metal. Its possible charges are 2+ and 1+. The more common charge is 2+.

CuCl_2 is copper (II) chloride, and CuCl is copper (I) chloride.

Example 2:

Iron is a multi-valent metal. Its possible charges are 3+ and 2+. The more common charge is 3+.

Fe_2O_3 is iron (III) oxide, and FeO is iron (II) oxide.

Note that the sum of all charges in a compound must equal zero.

If a transition metal is not multi-valent, then there is no need for the Roman numeral in parenthesis. For example, AgCl is silver chloride, and ZnCl_2 is zinc chloride.

Practice exercise:

Supply the chemical formula for the following compounds.

1. manganese (IV) oxide
2. copper (II) bromide
3. cobalt (II) chloride
4. silver nitrate
5. zinc sulfide
6. iron (III) chloride
7. nickel (II) oxide
8. copper (II) sulfate
9. mercury (II) sulfide
10. lead (IV) sulfide

Nomenclature Naming Binary Ionic Compounds

The name of a binary ionic compound is the name of the metal ion (the positively charged ion or cation) stated in full followed by the name of the non-metal ion (the negatively charged ion or anion) with the suffix *-ide*. For example,

AlCl_3 is aluminum chloride

CaO is calcium oxide

MgS is magnesium sulfide

Practice exercise:

If the IUPAC name is given, write the chemical formula. If the formula is supplied, write the IUPAC name.

1. calcium chloride
2. MgBr_2
3. aluminum fluoride
4. potassium iodide
5. BeCl_2
6. sodium bromide
7. LiCl
8. K_3N
9. calcium sulfide
10. MgO

Compounds with polyatomic ions

Predicting the formula of ionic compounds involving polyatomic ions is done in the same way as for binary ionic compounds.

For example, potassium nitrate is KNO_3 and calcium nitrate is $\text{Ca}(\text{NO}_3)_2$.

Sec 4 students should be familiar with the following polyatomic ions and charges.

Polyatomic ion	formula	charge
ammonium	NH_4^+	1+
hydroxide	OH^-	1-
nitrate	NO_3^-	1-
carbonate	CO_3^{2-}	2-
sulfate	SO_4^{2-}	2-
phosphate	PO_4^{3-}	3-

Practice exercise:

Supply chemical formulas for the following ionic compounds.

1. calcium carbonate
2. sodium hydroxide
3. ammonium chloride
4. sodium phosphate

Nomenclature Practice Exercise

Supply the chemical formula for the following ionic compounds.

1. nickel (II) oxide
2. magnesium carbonate
3. zinc sulfide
4. aluminum oxide
5. iron (III) chloride
6. silver nitrate
7. lithium chloride
8. ammonium hydroxide
9. copper (II) sulfate
10. potassium hydroxide
11. calcium hydroxide
12. sodium phosphate
13. cobalt (II) chloride
14. silver bromide
15. zinc carbonate
16. lead (II) iodide
17. copper (II) bromide
18. calcium fluoride
19. iron (III) hydroxide
20. magnesium sulfate
21. magnesium sulfide
22. nickel (II) sulfide
23. ammonium nitrate

Naming binary covalent compounds

According to IUPAC rules, the prefix system is used only for naming binary covalent compounds – molecular compounds composed of only two kinds of atoms.

Prefixes used in naming covalent compounds

mono	1
di	2
tri	3
tetra	4
penta	5
hexa	6
hepta	7

Exceptions to the above rule include the common molecular (covalent) compounds below:

water	H_2O
hydrogen peroxide	H_2O_2
ammonia	NH_3
propane	C_3H_8
octane	C_8H_{18}

Practice exercise:

Supply the formula for the following molecular compounds.

- 1) nitrogen dioxide
- 2) nitrogen monoxide
- 3) sulfur dioxide
- 4) sulfur trioxide
- 5) ammonia
- 6) propane
- 7) phosphorus trichloride
- 8) phosphorus pentachloride
- 9) hydrogen peroxide
- 10) carbon monoxide

Nomenclature Practice exercise

If a formula is given, write the IUPAC name. If the name is supplied, write the chemical formula.

1. carbon dioxide _____
2. calcium fluoride _____
3. K_2O _____
4. $Ca(OH)_2$ _____
5. K_3PO_4 _____
6. ammonium chloride _____
7. sulfur dioxide _____
8. PCl_3 _____
9. copper (II) nitrate _____
10. iron (III) hydroxide _____
11. N_2O_4 _____
12. NH_3 _____
13. $Zn(NO_3)_2$ _____
14. sodium carbonate _____
15. PCl_5 _____
16. sulfate ion _____
17. potassium _____
18. carbon monoxide _____
19. chloride ion _____
20. mercury _____
21. zinc oxide _____
22. nitrate ion _____