

IONIC COMPOUNDS

These consist of any positive ion (except H^+) combined with any negative ion. If H^+ is the positive ion, the compound is an ACID (once again, hydrogen plays by its own rules.)

- The positive ion (cation) may be a metal (such as Na^+) or a polyatomic ion (such as NH_4^+).
- The negative ion (anion) may be a non-metal ion (such as Cl^-) or a polyatomic ion (such as SO_4^{2-} or NO_3^-).

All names follow the same general format: cation is cited first & anion is cited second.

Case 1 – Ionic Compounds: Fixed Charge Metal + Non-metal

Name format: Metal Name + Anion Name

- Metal is always named first (name unchanged)
- Anion named second

Examples: KBr potassium bromide
 $AlCl_3$ aluminum chloride
 Li_3N lithium nitride

Note: The name does NOT indicate how many of each atom. Everyone has memorized their ions, so they know how many are needed to create a compound with zero net charge.

1. Write formulas for the following cations:

barium ion Ba^{2+} aluminum ion Al^{3+} potassium ion K^+

2. Write formulas for the following anions:

bromide Br^- nitride N^{3-} iodide I^- oxide O^{2-} sulfide S^{2-}

3. Name the following compounds:

SrI_2 strontium iodide

Ca_3N_2 calcium nitride

K_2O potassium oxide

Al_2O_3 aluminum oxide

Ba_3N_2 barium nitride

Na_3P sodium phosphide

4. Give formulas for the following compounds – refer to the periodic table only.

potassium phosphide K_3P

calcium iodide CaI_2

strontium chloride $SrCl_2$

magnesium nitride Mg_3N_2

zinc bromide $ZnBr_2$

lithium sulfide Li_2S

Case 2 - Ionic Compounds: Transition Metal + Non-metal

Name format: Metal Name + Roman Numeral + Anion Name

In general, it is NOT possible to use the periodic table to predict what ions are formed by transition metals. You need to know the charge of the anions to determine the charge of most transition metals.

For transition metals that form two ions, the naming system is as follows:

Modern System:

- Metal is always first (name unchanged)
- A Roman numeral in parentheses indicating the charge on the metal ion
- There are 3 transition metals that do NOT require a Roman Numeral: Ag^+ , Zn^{2+} & Cd^{2+} .
- Non-metal with the ending changed to -IDE

Examples	FeF_2	iron(II) fluoride
	SnO_2	tin(IV) oxide
	Cu_3P	copper(I) phosphide

Old System:

- -ous ending refers to the ion with lower charge
- -ic ending refers to the ion with higher charge

Examples

Fe^{2+}	ferrous	Fe^{3+}	ferric	Cr^{2+}	chromous	Cr^{3+}	chromic
Cu^+	cuprous	Cu^{2+}	cupric	Sn^{2+}	stannous	Sn^{4+}	stannic
Pb^{2+}	plumbous	Pb^{4+}	plumbic				

FeF_2	ferrous fluoride
SnO_2	stannic oxide
Cu_3P	cuprous phosphide

5. Name the following compounds using Modern and Old Names if applicable.

	Modern Name (use Roman Numerals)	Old Name (use '-ic' or '-ous')
SnCl_2	<u>tin(II) chloride</u>	<u>stannous chloride</u>
FeBr_3	<u>iron(III) bromide</u>	<u>ferric bromide</u>
Cu_3N	<u>copper(I) nitride</u>	<u>cuprous nitride</u>

6. Give formulas for the following compounds.

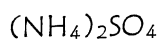
chromium(III) oxide	<u>Cr_2O_3</u>	stannous fluoride	<u>SnF_2</u>
ferrous iodide	<u>FeI_2</u>	zinc nitride	<u>Zn_3N_2</u>
cupric bromide	<u>CuBr_2</u>	cobalt(II) oxide	<u>CoO</u>

Case 3 – Ionic Compounds: Polyatomic Ions as the Cation or Anion

Name format: Cation Name + Anion Name

Now we will introduce the polyatomic cations and anions. Notice that the format for each name remains the same. We still list the cation name first and the anion name second. If the cation is a variable charge metal, then we must continue indicating the charge with a Roman numeral.

Examples



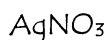
ammonium sulfate



iron(II) oxide



iron(III) oxide



silver nitrate

7. Give the names for the following ionic compounds.

NH_4Cl ammonium chloride

NaHCO_3 sodium bicarbonate

$\text{Ca}(\text{OH})_2$ calcium hydroxide

AlPO_4 aluminum phosphate

AgNO_3 silver nitrate

$\text{Sn}(\text{CO}_3)_2$ tin(IV) carbonate

8. Give the chemical formula for the following ionic compounds.

Copper(II) cyanide $\text{Cu}(\text{CN})_2$

Chromium(III) carbonate $\text{Cr}_2(\text{CO}_3)_3$

Tin(IV) bisulfate $\text{Sn}(\text{HSO}_4)_4$

Ammonium hydroxide NH_4OH

Zinc bromide ZnBr_2

COVALENT COMPOUNDS – two or more non-metals

When non-metal atoms **share** electrons with other non-metal atoms, they form **covalent (molecular) compounds**. We shall learn the nomenclature for binary covalent compounds. A binary covalent compound is a compound formed by only two elements.

Case 4 – Binary Covalent Compounds

Name format: Greek prefix + 1st Non-metal + Greek Prefix + 2nd Non-metal prefix + "ide"

- The less electronegative atom is first and assumes the position of the 'cation.'
- The more electronegative atom is last and gets an -IDE ending.
- The number of each atom is specified with a Greek prefix.

The Greek prefixes you need to know are:

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

- Note:
1. When there is only one atom of the first element, the mono prefix is omitted.
 2. When oxygen requires a prefix, the last vowel of the prefix is omitted if it is an 'a'

Examples	NF ₃	nitrogen trifluoride
	I ₂ S	diiodine monosulfide
	P ₄ O ₁₀	tetraphosphorus decoxide

You must memorize these very important common names.

H ₂ O (water)	NH ₃ (ammonia)	CH ₄ (methane)	H ₂ O ₂ (hydrogen peroxide)
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9. Name the following compounds.

N ₂ O ₄	<u>dinitrogen tetroxide</u>	PCl ₅	<u>phosphorus pentachloride</u>
SO ₂	<u>sulfur dioxide</u>	SO ₃	<u>sulfur trioxide</u>
CS ₂	<u>carbon disulfide</u>	Br ₂ O ₇	<u>dibromine heptoxide</u>
CO	<u>carbon monoxide</u>	P ₂ O ₅	<u>diphosphorous pentoxide</u>

10. Give formulas for the following compounds.

iodine pentabromide	<u>IBr₅</u>	chlorine dibromide	<u>ClBr₂</u>
oxygen difluoride	<u>OF₂</u>	carbon tetrachloride	<u>CCl₄</u>
sulfur hexafluoride	<u>SF₆</u>	iodine heptafluoride	<u>IF₇</u>

Case 5 – Diatomic Molecules

Several common non-metal elements exist as diatomic molecules. The element name refers to the diatomic molecule. For example, hydrogen refers to H_2 and oxygen refers to O_2 . If we mean the atom, we say atomic hydrogen or atomic oxygen.

11. List the 7 elements that exist as diatomic molecules: H_2 N_2 F_2 O_2 I_2 Cl_2 Br_2

12. Write the chemical formula for the underlined names of the gases.

Ar Dry air contains about 79% nitrogen and 21% oxygen, with small amounts of carbon dioxide, neon, and argon. Polluted air may contain small amounts of sulfur dioxide, sulfur trioxide, nitrogen dioxide, dinitrogen monoxide, chlorine, ammonia, methane and carbon monoxide.

N_2 O_2 CO_2 Ne
 ↓ ↓ ↓ ↓ ↓ ↓ ↓
 Cl_2 NH_3 CH_4 CO SO_2 SO_3 NO_2 N_2O

13. Write the chemical name for the chemical formulas in the following paragraph.

Probably the most important element found uncombined in nature is O_2 . O_2 is quite reactive, forming compounds with the halogens F_2 , Cl_2 , Br_2 , and I_2 . O_2 forms two compounds with H_2 . Following the usual rules of nomenclature, the most common oxide of hydrogen (H_2O) would be name dihydrogen monoxide. O_2 forms a series of compounds with N_2 , many of which are atmospheric pollutants, including NO , N_2O , NO_2 , N_2O_4 , and N_2O_5 .

O_2 = oxygen

F_2 = fluorine

Cl_2 = chlorine

Br_2 = bromine

I_2 = iodine

H_2 = hydrogen

NO = nitrogen monoxide

N_2O = dinitrogen monoxide

NO_2 = nitrogen dioxide

N_2O_4 = dinitrogen tetroxide

N_2O_5 = dinitrogen pentoxide

Now Put it All Together

14. Write the chemical name for each formula.

BaCl_2 barium chloride

F_2 fluorine

N_2 nitrogen

LiNO_3 lithium nitrate

N_2O_5 dinitrogen pentoxide

OF_2 oxygen difluoride

NiCl_4 nickel (IV) chloride

P_4S_3 tetraphosphorus trisulfide

Fe_2O_3 iron (III) oxide

AuF_3 gold (III) fluoride

PbBr_2 lead (II) bromide

$\text{Cr}(\text{CN})_3$ chromium (III) cyanide

Cu_2O copper (I) oxide

$\text{Sn}(\text{SO}_4)_2$ tin (IV) sulfate

CuSO_4 copper (II) sulfate

SO_2 sulfur dioxide

$\text{Cr}(\text{CH}_3\text{CO}_2)_3$ chromium (III) acetate

$\text{Sr}_3(\text{PO}_4)_2$ strontium phosphate

ZnCO_3 zinc carbonate

Cl_2 chlorine

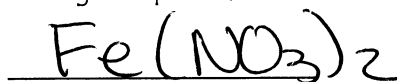
KClO potassium hypochlorite (KClO)

CO_2 carbon dioxide

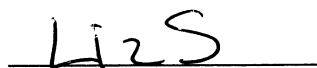
oops ;)

15. Write the formula for the following compounds.

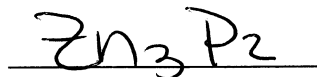
iron(II) nitrate



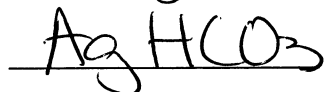
lithium sulfide



zinc phosphide



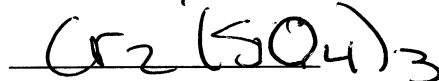
silver bicarbonate



sulfur hexafluoride



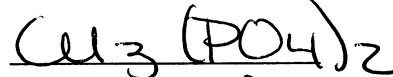
chromium(III) sulfate



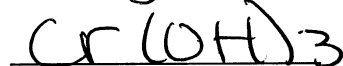
ammonium acetate



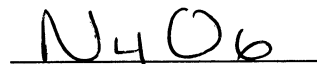
copper(II) phosphate



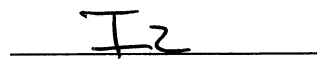
chromium(III) hydroxide



tetranitrogen hexoxide



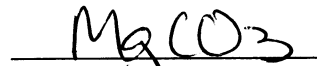
iodine



nitrogen trichloride



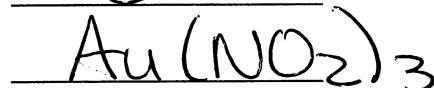
magnesium carbonate



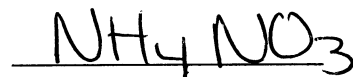
oxygen



gold(III) nitrite



ammonium nitrate



tin(IV) sulfite



aluminum phosphate

