

Nomenclature Summary

Follow these steps to convert chemical formulas to names.

Step 1: Classify the formula as representing one of the following types of compounds.

- Binary ionic
- Ionic with a polyatomic ion
- Binary covalent
- Binary acid
- Oxyacid
- Alcohol
- Sugar

Identifying types of compounds from formulas.

Type of compound	General formula	Example
binary ionic	M_aA_b	NaCl
ionic with an oxyanion (polyatomic ion)	$M_aH_bX_cO_d$ or $(NH_4)_aH_bX_cO_d$ (b can be 0)	Li_2HPO_4 or $NaNO_3$ or NH_4NO_3
binary covalent	A_aB_b	N_2O_5
binary acid	$HX(aq)$ or $H_2X(aq)$	$HCl(aq)$ or $H_2S(aq)$
oxyacid	$H_aX_bO_c$	H_2SO_4
hydrocarbon	C_aH_b	C_2H_6
alcohol	memorize examples	CH_3OH , C_2H_5OH , C_3H_7OH
sugar	memorize examples	$C_6H_{12}O_6$, $C_{12}H_{22}O_{11}$

M = symbol of metal

A and B = symbols of nonmetals

X = some element other than H or O

a, b, c & d indicate subscripts

Step 2: Apply the following steps to name each type of substance.

Ionic

1. Ionic compounds are named by writing the name for the cation followed by the name for the anion. The tables below summarize the ways ions are named.

Type of cation	General name	Example
For metals with one possible charge (Groups 1, 2, 3, Al, Ag, Cd, and Zn)	name of metal	Mg^{2+} is magnesium.
For metals with more than one possible charge (The rest of the metals)	name of metal(Roman numeral)	Cu^{2+} is copper(II).
Polyatomic cations	Ammonium is our only example in this category.	NH_4^+ is ammonium.

Type of anion	General name	Example
For monatomic anions	(root of nonmetal)ide	O^{2-} is oxide.
For polyatomic anions	name of polyatomic ion	NO_3^- is nitrate.

2. When the metal in an ionic formula has more than one charge, you need to be able to figure out the charge from the formula. This is done by determining the charge on the anion and finding the charge on the cation that would yield an uncharged overall formula. The following examples will illustrate this.

To determine the charge on the copper ions in CuCl , you first determine the charge on the chloride ions. Because Cl is in group 17 or 7A, it forms -1 ions. The copper cation must be $+1$ to balance the -1 of the chloride to yield an uncharged ionic formula. The name of this compound is copper(I) chloride.

In CoCl_2 the cobalt must be $+2$ to balance the -2 from the two -1 chlorides. The name of this compound is cobalt(II) chloride.

To determine the charge on the iron ions in Fe_2O_3 , you first determine the charge on the oxide ions. Because oxygen atoms have two less electrons than the nearest noble gas, neon, they form -2 ions. The iron must be $+3$ because it would take two $+3$ iron ions to balance the -6 from the three -2 oxides. The name of this compound is iron(III) oxide.

The names of some polyatomic ions need to be memorized.

Polyatomic ions with common names.

Ion	Name	Ion	Name
OH^-	hydroxide	NH_4^+	ammonium
CN^-	cyanide	$\text{C}_2\text{H}_3\text{O}_2^-$	acetate
$\text{C}_2\text{O}_4^{2-}$	oxalate	MnO_4^-	permanganate
$\text{Cr}_2\text{O}_7^{2-}$	dichromate		

(Root)ate Polyatomic Ions

Ion	Name	Ion	Name
SO_4^{2-}	sulfate	NO_3^-	nitrate
PO_4^{3-}	phosphate	CO_3^{2-}	carbonate
ClO_3^-	chlorate	CrO_4^{2-}	chromate
BrO_3^-	bromate	IO_3^-	iodate

Some polyatomic ion names can be determined by applying the following convention.

Convention for Naming Oxyanions

Relationship	General Name	Example Name	Example Formula
one more oxygen atom than (root)ate	per(root)ate	perchlorate	ClO_4^-
	(root)ate	chlorate	ClO_3^-
one less oxygen atom than (root)ate	(root)ite	chlorite	ClO_2^-
two less oxygen atoms than (root)ate	hypo(root)ite	hypochlorite	ClO^-

Some polyatomic ions are made by adding H^+ ions to polyatomic ions with charge greater than -1 .

Formula and Names for Polyatomic Ions Containing Hydrogen

Formula	Name	Formula	Name
HCO_3^-	hydrogen carbonate	HPO_4^{2-}	hydrogen phosphate
HS^-	hydrogen sulfide	H_2PO_4^-	dihydrogen phosphate

Some polyatomic ions have common (nonsystematic) names.

Systematic and Nonsystematic Names for Some Polyatomic Ions

Formula	Systematic (Preferred) Name	Nonsystematic Name
HCO_3^-	hydrogen carbonate	bicarbonate
HSO_4^-	hydrogen sulfate	bisulfate
HSO_3^-	hydrogen sulfite	bisulfite

Note: You should use the systematic name, but it will also be useful to know the nonsystematic names.

Step 2 (continued)

Binary covalent

There are three categories of binary covalent compounds, and there are different ways to name compounds in each category.

Some binary covalent compounds have common names. Here's a starter list to memorize.

water	H ₂ O	ammonia	NH ₃
methane	CH ₄	ethane	C ₂ H ₆
propane	C ₃ H ₈	butane	C ₄ H ₁₀
pentane	C ₅ H ₁₂	hexane	C ₆ H ₁₄

Some pairs of nonmetals only combine in one ratio, so the prefixes can be left off in their names. You will be expected to recognize the following as being in this category.

Formula	Complete name	Common name
HF	hydrogen monofluoride	hydrogen fluoride
HCl	hydrogen monochloride	hydrogen chloride
HBr	hydrogen monobromide	hydrogen bromide
HI	hydrogen moniodide	hydrogen iodide
H ₂ S	dihydrogen sulfide	hydrogen sulfide

Many pairs of nonmetal elements can have their atoms combine in more than one ratio. We will assume that any binary covalent compound not on our list of compounds with common names and not on our list of binary covalent compounds with elements that combine in only one ratio includes nonmetals that can combine in more than one ratio.

For example, nitrogen and oxygen form compounds with formulas of NO, N₂O, NO₂, NO₃, N₂O₃, and N₂O₅. We will describe these using prefixes. For example, N₂O₃ is dinitrogen trioxide.

Prefixes Used in the Names of Binary Covalent Compounds to Indicate the Number of Atoms of each Element in the Formula

Number of atoms	Prefix	Number of atoms	Prefix
1	mon(o)-	6	hex(a)-
2	di-	7	hept(a)-
3	tri-	8	oct(a)-
4	tetr(a)-	9	non(a)-
5	pent(a)-	10	dec(a)-

Follow these steps to write the names for compounds in this category.

1. If the subscript for the first element is greater than one, indicate the subscript with a prefix.

Leave the “a” off the end of the prefixes that end in “a” if they are placed in front of an element that begins with a vowel, for example, oxygen or iodine.

We never write mono- on the first name.

2. Follow the prefix with the name of the first element in the formula.

3. Write a prefix to indicate the subscript for the second element.

Leave off the “o” from the end of mono and the “a” from the end of the prefixes that end in “a” when these prefixes are before ox- or iod-.

If there is a prefix on the first name and if there is only one atom for the second element, the mono- can be left out.

4. Write the root of the name of the element that corresponds to the second symbol in the formula.

5. Write -ide at the end of the name.

Roots for the Nonmetals

Element	Root	Element	Root	Element	Root	Element	Root
C	carb-	N	nitr-	O	ox-	F	fluor-
		P	phosph-	S	sulf-	Cl	chlor-
		As	arsen-	Se	selen-	Br	brom-
						I	iod-

Names for Binary Covalent Compounds with Atoms that Combine in Only One Ratio

Formula	Complete Name	Common Name
HF	hydrogen monofluoride	hydrogen fluoride
HCl	hydrogen monochloride	hydrogen chloride
HBr	hydrogen monobromide	hydrogen bromide
HI	hydrogen moniodide	hydrogen iodide
H ₂ S	dihydrogen monosulfide (or dihydrogen sulfide)	hydrogen sulfide

Step 2 (continued)

Binary acids

Binary acids are named by writing “hydro-” followed by the root of the name of the element other than hydrogen, then “-ic” and finally “acid”.

hydro(root)ic acid

The names of the binary acids are on the following table. Note that for $\text{H}_2\text{S}(aq)$ uses the whole name, sulfur, in the center rather than the root for sulfur, sulf-.

Formula	Named as binary covalent	Formula	Named as binary acid
HF	hydrogen monofluoride or hydrogen fluoride	$\text{HF}(aq)$	hydrofluoric acid
HCl	hydrogen monochloride or hydrogen chloride	$\text{HCl}(aq)$	hydrochloric acid
HBr	hydrogen monobromide or hydrogen bromide	$\text{HBr}(aq)$	hydrobromic acid
HI	hydrogen moniodide or hydrogen iodide	$\text{HI}(aq)$	hydroiodic acid
H_2S	dihydrogen sulfide or hydrogen sulfide	$\text{H}_2\text{S}(aq)$	hydrosulfuric acid

Step 2 (cont.)

Oxyacids

It is common that one element can form more than one oxyacid. For example, chlorine can form four oxyacids: HClO , HClO_2 , HClO_3 , and HClO_4 . If there are four possible oxyacids, the following convention is used to distinguish between them.

The oxyacid with the most oxygen atoms will be named by writing *per-*, then the root of the name for the element other than hydrogen and oxygen, then *-ic*, and then *acid*. For example, HClO_4 is perchloric acid.

The oxyacid with one less oxygen atom than the per(root)ic acid is named by writing the root of the name for the element other than hydrogen and oxygen, then *-ic*, and then *acid*. For example, HClO_3 is chloric acid.

The oxyacid with one less oxygen atom than the (root)ic acid is named by writing the root of the name for the element other than hydrogen and oxygen, then *-ous*, and then *acid*. For example, HClO_2 is chlorous acid.

The oxyacid with two less oxygen atoms than the (root)ic acid is named by writing *hypo-*, then the root of the name for the element other than hydrogen and oxygen, then *-ous*, and then *acid*. For example, HClO is hypochlorous acid.

Convention for Naming Oxyacids

Relationship	General Name	Example Name	Example Formula
one more oxygen atom than (root)ic	per(root)ic acid	perchloric acid	HClO_4
	(root)ic acid	chloric acid	HClO_3
one less oxygen atom than (root)ic	(root)ous acid	chlorous acid	HClO_2
two less oxygen atoms than (root)ic	hypo(root)ous acid	hypochlorous acid	HClO

There are not always four possibilities for the oxyacids of an element. If there are only three possibilities, the per(root)ic acid is not used. If there are only two possibilities, only the (root)ic acid and the (root)ous acid are used. If there is only one possibility, only the (root)ic acid is used.

The (root)ic acids come from the (root)ate polyatomic ions, so you can determine the (root)ic acid from your memorized (root)ate polyatomic ions. For example, if you add enough H^+ ions to neutralize the negative charge on sulfate, SO_4^{2-} , it forms sulfuric acid, H_2SO_4 . Nitrate, NO_3^- , forms nitric acid, HNO_3 . When three H^+ ions are added to phosphate, PO_4^{3-} , phosphoric acid, H_3PO_4 , forms. Note that the whole name for sulfur, not the root, sulf-, is found in the name sulfuric acid. There is a similar situation for phosphoric acid. The usual root for phosphorus is phosph-, but phosphor- is used in its place for oxyacids containing phosphorus.

Relationship Between the (Root)ate Polyatomic Ions and the (Root)ic Acids

Oxyanion formula	Oxyanion name	Oxyacid formula	Oxyacid name
NO_3^-	nitrate	HNO_3	nitric acid
$C_2H_3O_2^-$	acetate	$HC_2H_3O_2$	acetic acid
SO_4^{2-}	sulfate	H_2SO_4	sulfuric acid (Note that the whole name sulfur is used in the oxyacid name.)
CO_3^{2-}	carbonate	H_2CO_3	carbonic acid
PO_4^{3-}	phosphate	H_3PO_4	phosphoric acid (Note that an the root of phosphorus in an oxyacid name is phosphor-.)
ClO_3^-	chlorate	$HClO_3$	chloric acid
BrO_3^-	bromate	$HBrO_3$	bromic acid
IO_3^-	iodate	HIO_3	iodic acid
$C_2O_4^{2-}$	oxalate	$H_2C_2O_4$	oxalic acid
CrO_4^{2-}	chromate	H_2CrO_4	chromic acid

Note: When enough H^+ ions are added to the (root)ate polyatomic ion to completely neutralize the charge, the (root)ic acid forms.

Alcohols

You will only be expected to know the names and formulas for the alcohols on the following table.

Correct name	Common name	Formula
methanol	methyl alcohol	CH_3OH
ethanol	ethyl alcohol	C_2H_5OH
2-propanol	isopropyl alcohol	C_3H_7OH

Sugars

You will only be expected to know the names and formulas for the following sugars.

Name	Formula
glucose	$C_6H_{12}O_6$
sucrose	$C_{12}H_{22}O_{11}$

Follow these steps to write formulas from names of compounds for binary ionic compounds, ionic compounds with polyatomic ions, binary covalent compounds, binary acids, oxyacids, alcohols, and sugars.

Step 1: Identify the type of compound the name represents.

Identifying Types of Compounds from Names

Type of Compound	Tip-off	Examples
binary ionic	-ide ending with metal-nonmetal	sodium chloride
ionic with an oxyanion	-ite or -ate ending	sodium nitrate
binary covalent		
a. with common names	recognize name	water or methane
b. hydrocarbons	There are other possibilities, but those we will see will include: (root)ane	n-pentane
c. Other	-ide ending with nonmetal-nonmetal	nitrogen trifluoride
binary acid	hydro(root)ic acid	hydrochloric acid
oxyacid	per(root)ic acid (root)ic acid (root)ous acid hypo(root)ous acid	perchloric acid chloric acid chlorous acid hypochlorous acid
alcohol	name ends in -anol or alcohol	methanol or methyl alcohol
sugar	name ends in -ose	glucose or sucrose

Step 2: Apply the following guidelines to write formulas for each type of compound.

Binary Ionic and Ionic with Polyatomic Ions

Follow these steps to write formulas for ionic compounds.

1. Write the formula including charge for the cation.

The charges of some metal ions can be determined from the periodic table. Metals tend to lose enough electrons (up to three) to get the same number of electrons as the nearest noble gas.

Elements	Charges
Group 1	+1
Group 2	+2
Group 3 and aluminum	+3

3. The next step is to write subscripts for each formula that will yield a neutral compound.

Use the lowest whole number ratio for the subscripts.

The following table shows the possible ratios.

If the subscript for a polyatomic ion is more than one, place the formula for the polyatomic ion in parentheses and put the subscript outside the parentheses.

General Ionic charges	General Formula	Example Ions	Example Formula
C^+ and A^-	CA	Na^+ and Cl^-	NaCl
C^+ and A^{2-}	C_2A	NH_4^+ and SO_4^{2-}	$(NH_4)_2SO_4$
C^+ and A^{3-}	C_3A	Li^+ and PO_4^{3-}	Li_3PO_4
C^{2+} and A^-	CA_2	Mg^{2+} and NO_3^-	$Mg(NO_3)_2$
C^{2+} and A^{2-}	CA	Ca^{2+} and CO_3^{2-}	$CaCO_3$
C^{2+} and A^{3-}	C_3A_2	Ba^{2+} and N^{3-}	Ba_3N_2
C^{3+} and A^-	CA_3	Al^{3+} and I^-	AlI_3
C^{3+} and A^{2-}	C_2A_3	Sc^{3+} and S^{2-}	Sc_2S_3
C^{3+} and A^{3-}	CA	Fe^{3+} and PO_3^{3-}	$FePO_3$

Binary Covalent

1. When the name has one of these forms,

prefix(name of nonmetal) prefix(root of nonmetal)ide

or (name of nonmetal) prefix(root of nonmetal)ide

or prefix(name of nonmetal) (root of nonmetal)ide

follow these steps.

Write the symbols for the elements in the name in the order mentioned.

Write subscripts indicated by the prefixes. If one of the names has no prefix, assume it to be mono-.

2. Some binary covalent compounds have common names. You will be expected to recognize the following.

water	H_2O	ammonia	NH_3
methane	CH_4	ethane	C_2H_6
propane	C_3H_8	butane	C_4H_{10}
pentane	C_5H_{12}	hexane	C_6H_{14}

3. Some pairs of nonmetals only combine in one ratio, so the prefixes can be left off in their names. You will be expected to recognize the following as being in this category.

Formula	Complete Name	Common Name
HF	hydrogen monofluoride	hydrogen fluoride
HCl	hydrogen monochloride	hydrogen chloride
HBr	hydrogen monobromide	hydrogen bromide
HI	hydrogen moniodide	hydrogen iodide
H_2S	dihydrogen sulfide	hydrogen sulfide

Binary Acids

1. The name for a binary acid is in the form hydro(root)ic acid. You will be expected to be able to write formulas for the binary acids found on the following table. It is a good habit to put the (aq) after the formula.

Formula	Named as Binary Covalent	Formula	Named as Binary acid
HF	hydrogen monofluoride or hydrogen fluoride	HF(aq)	hydrofluoric acid
HCl	hydrogen monochloride or hydrogen chloride	HCl(aq)	hydrochloric acid
HBr	hydrogen monobromide or hydrogen bromide	HBr(aq)	hydrobromic acid
HI	hydrogen moniodide or hydrogen iodide	HI(aq)	hydroiodic acid
H ₂ S	dihydrogen sulfide or hydrogen sulfide	H ₂ S(aq)	hydrosulfuric acid

2. In order to determine the ratios, it might be useful to view the compounds as forming from H⁺ ions being added to the -1 halogen ions or the -2 sulfide ion.

Oxyacids

1. You can either memorize the formulas for some of the oxyacids of the form (root)ic acid, or you can figure them out from the names and formulas of the (root)ate polyatomic ions.

H ₂ SO ₄	sulfuric acid	HNO ₃	nitric acid
H ₃ PO ₄	phosphoric acid	H ₂ CO ₃	carbonic acid
HClO ₃	chloric acid	HC ₂ H ₃ O ₂	acetic acid
HBrO ₃	bromic acid	H ₂ CrO ₄	chromic acid
HIO ₃	iodic acid		

The -ic acids come from the (root)ate polyatomic ions, so you can determine the (root)ic acid from your memorized (root)ate polyatomic ions.

For example, if you add enough H⁺ ions to neutralize the negative charge on sulfate, SO₄²⁻ sulfuric acid, H₂SO₄, forms.

Nitrate, NO₃⁻ forms nitric acid, HNO₃.

When three H⁺ ions are added to phosphate, PO₄³⁻ phosphoric acid, H₃PO₄, forms.

2. If the name of the oxyacid is not in the form (root)ic acid, determine the formula from the convention on the following table.

Relationship	General name	Example name	Example formula
one more oxygen atom than (root)ic	per(root)ic acid	perchloric acid	HClO ₄
	(root)ic acid	chloric acid	HClO ₃
one less oxygen atom than (root)ic	(root)ous acid	chlorous acid	HClO ₂
two less oxygen atoms than (root)ic	hypo(root)ous acid	hypochlorous acid	HClO

Alcohols

You will only be expected to know the names and formulas for the alcohols on the following table.

Correct name	Common name	Formula
methanol	methyl alcohol	CH_3OH
ethanol	ethyl alcohol	$\text{C}_2\text{H}_5\text{OH}$
2-propanol	isopropyl alcohol	$\text{C}_3\text{H}_7\text{OH}$

Sugars

You will only be expected to know the names and formulas for the following sugars.

Name	Formula
glucose	$\text{C}_6\text{H}_{12}\text{O}_6$
sucrose	$\text{C}_{12}\text{H}_{22}\text{O}_{11}$