

7 • Chemical Formulas Formula and Compound Terms (1 of 12)

anion	another name for a negative ion
cation	another name for a positive ion
binary compound	contains two elements
ternary compound	contains three or more elements
ionic compound	made of a positive & a negative ion
molecular compound	atoms share electrons...not ionic
covalent compound	same as molecular compound
chemical formula	shows # & kind of atoms (includes molecular, empirical and structural)
molecular formula	shows # & kind of atoms in molecule
empirical formula	simplest whole # ratio of atoms
structural formula	show how atoms are connected
monatomic: one atom	diatomic: two atoms

7 • Chemical Formulas Memorization Tips - Negative Ions (2 of 12)

all negative ions (anions) end in “-ide”, “-ate”, or “-ite”

”-ides”

- these are single atoms
- exceptions: hydroxide (OH^-) and cyanide (CN^-)
- you can tell charge from position on the periodic table.
- Family VII (F, Cl, Br, I) all form 1- ions.
- Family VI (O, S) all form 2- ions.

“-ates”

- these contain several oxygen atoms. You just have to memorize them... there is no rule about how many oxygens.

“-ites” contain one less O than the -ates... same charge.

7 • Chemical Formulas Memorization Tips - Positive Ions (3 of 12)

metals form + ions “-ous” ions < “-ic” ions

- Family I (Li, Na, K, etc.) all form 1+ ions
- Family II (Be, Mg, Ca, Sr, Ba, Ra) all form 2+ ions
- Family III (Al) forms a 3+ ion

mercury	mercurous, Hg_2^{2+} mercury(I)	mercuric, Hg^{2+} mercury(II)
copper	cuprous, Cu^+ copper(I)	cupric, Cu^{2+} copper(II)
tin	stannous, Sn^{2+} tin(II)	stannic, Sn^{4+} tin(IV)
iron	ferrous, Fe^{2+} iron(II)	ferric, Fe^{3+} iron(III)

Superscripts

used to show the charges on ions
 Mg^{2+} the 2 means a 2+ charge (lost 2 electrons)

Subscripts

used to show numbers of atoms in a formula unit
 H_2SO_4 two H's, one S, and 4 O's

Coefficients

used to show the number of formula units
 2Br^- the 2 means two individual bromide ions

Hydrates

$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
some compounds have water molecules included

7 • Chemical Formulas Formula Conventions (4 of 12)

**7 • Chemical Formulas
How Ions Form
(5 of 12)**

Positive ions form by LOSING one or more electrons.
Negative ions form by GAINING one or more electrons

PROTONS are not gained or lost from the nucleus except in nuclear reactions that require MUCH more energy than is usually available.

Metals become POSITIVE ions.
Non-Metals become NEGATIVE ions.
Semi-Metals sometimes become ions and sometimes share electrons as molecular compounds.

**7 • Chemical Formulas
Writing Ionic Formulas
(6 of 12)**

The positive ion is written first.

The total positive charge must match the total negative charge in the compound.

Use parentheses when you need several polyatomic ions...
 $\text{Al}_2(\text{SO}_4)_3$ is correct $\text{Al}_2(\text{Cl})_3$ is incorrect

Be careful of OH^- ions...
 $\text{Ba}(\text{OH})_2$ is correct BaOH_2 is incorrect

Reduce subscripts in final formula except with Hg_2^{2+}
 SnS_2 is correct Sn_2S_4 is incorrect
mercurous chloride, Hg_2Cl_2 is correct

**7 • Chemical Formulas
Other Ions (beyond the 40)
and how they relate to oxidation numbers
(7 of 12)**

bicarbonate, HCO_3^-	bisulfate, HSO_4^-
bisulfide, HS^-	biphosphate, HPO_4^{2-}
perchlorate	ClO_4^- oxidation number of Cl = +7
chlorate	ClO_3^- oxidation number of Cl = +5
chlorite	ClO_2^- oxidation number of Cl = +3
hypochlorite	ClO^- oxidation number of Cl = +1
chlorine	Cl_2 oxidation number of Cl = 0
chloride	Cl^- oxidation number of Cl = -1
chlorate	ClO_3^-
bromate	BrO_3^- similar to chlorate

**7 • Chemical Formulas
Oxidation Numbers
What they are and how you find them
(8 of 12)**

The oxidation number is the “**apparent charge**” on an atom.

The oxidation number of any substance in its elemental form is defined as 0.

Example: the oxidation number of H in H_2 is 0
the oxidation number of H in H_2O is +1

The oxidation numbers of each of the atoms in a substance add up to the charge on the substance...

$$\text{CO}_3^{2-} \quad \text{C} + \text{O} + \text{O} + \text{O} = -2$$
$$x + -2 + -2 + -2 = -2 \quad x = +4$$

$$\text{CH}_4 \quad \text{C} + \text{H} + \text{H} + \text{H} + \text{H} = 0$$
$$x + 4(+1) = 0 \quad x = -4$$

**7 • Chemical Formulas
Writing and Naming Acids
(9 of 12)**

Acids are ionic formulas in which the positive ion is H^+ .

Use as many H^+ ions as the charge on the negative ion.

Three rules for naming:

if the anion ends with:	the acid is named:
-ite	*****ous acid
-ate	*****ic acid
-ide	hydro*****ic acid

- Acids from sulfide, sulfite, and sulfate include a “ur”
 H_2S is hydrosulfuric acid, not hydrosulfic acid
- Acids from phosphate and phosphite include a “or”
 H_3PO_4 is phosphoric acid, not phosphic acid

**7 • Chemical Formulas
Stock Names vs. Traditional Names
(10 of 12)**

The Stock System of naming compounds is used...

- when a positive ion has more than one possible charge
(i.e. cuprous, cupric, etc.)

Traditional:	mercurous, Hg_2^{2+}	mercuric, Hg^{2+}
Stock:	mercury(I)	mercury(II)
Traditional:	cuprous, Cu^+	cupric, Cu^{2+}
Stock:	copper(I)	copper(II)

- for molecular compounds where the elements have many different oxidation numbers (i.e. N in NO_2 , NO , N_2O , etc.)

	Stock Name:	Traditional Name:
NO_2	nitrogen(IV) oxide	nitrogen dioxide
NO	nitrogen (II) oxide	nitrogen monoxide

**7 • Chemical Formulas
Naming Molecular Compounds
(Traditional Method)
(11 of 12)**

The first element is named using the name of the element.
The second element always end in “-ide.”

Indicate the number of atoms using the prefix...

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

If the first element has only one atom, don't use the mono-
If the second element is oxygen, drop the vowel...
monoxide, not monooxide
tetroxide, not tetraoxide

**7 • Chemical Formulas
Determining Ions from Formulas
(12 of 12)**

Given the formula of an ionic compound, you can determine the original ions.

Most of these problems are obvious **if you have the ions memorized**...

$NaCl$	Na^+	Cl^-
K_2SO_4	K^+	SO_4^{2-}

Some need a little “detective work”...

CuS Cu^+ or Cu^{2+} ?
since S is 2^- (memorized) Cu must be 2^+ .

You can also figure out ions you've never seen before...

$Ga(NO_3)_3$ must be Ga^{3+} since NO_3^- (memorized)