Naming Simple Binary Compounds

Covalent compound

The IUPAC number prefixes (similar to Greek) are used for each element forming the compound. "mono" is omitted for the first element.

name of the first element + second element root + "ide"

e.g. CS_2 is "carbon disulfide", N_2O is "dinitrogen monoxide.
(with a space between the two words)

Element placed on the left in the periodic table is named first

In the same family (column), the heaviest element is named first

IUPAC prefix

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

Ionic compound

positive ion (cation) is named first, negative ion (anion) is named second

name of the metal + anion root + "ide"

e.g. $CaBr_2$ is "calcium bromide"
Since the charges are always balanced, the IUPAC prefix is useless
It is a **mistake** to write: calcium dibromide

Metal with several possible charges

e.g. transition metal like Fe^{2+}, Fe^{3+}

use roman numerical within parentheses

the roman number corresponds to the oxidation state (charge) of the ion.

e.g. $FeCl_2$ is "iron(II) chloride"

never use the roman numerical for an ion which can only have one oxidation state

e.g. $ZnCl_2$ is "zinc chloride"

Oxyanions

anion containing oxygen

family of two

e.g. SO_4^{2-} is "sulfate", SO_3^{2-} is "sulfite"
high amount of oxygen = -ate
low amount of oxygen = -ite

family of four oxyanions (Cl, Br, I)

4 oxygen atom = "per-*root*-ate"
3 oxygen atom = "*root*-ate"
2 oxygen atom = "*root*-ite"
1 oxygen atom = "hypo-*root* -ite"
e.g. ClO_4^- is "perchlorate"

Hydrated compound

water molecule attached to the compound

e.g. $MgSO_4 \cdot 7H_2O$ is "magnesium sulfate heptahydrate"

use the IUPAC prefix with each water formula unit "hydrate"

Acid (aqueous acidic proton: H-X)   anion + "-ic acid"

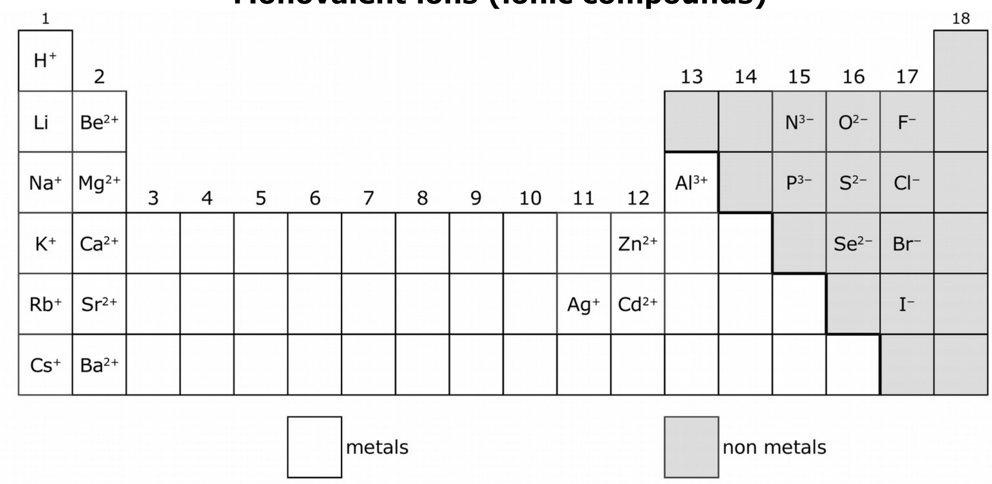
e.g. $H_2SO_4(aq)$ = sulfuric acid

anions without oxygen starts with "hydro"
e.g. $H_2S(aq)$ = hydrosulfuric acid

anions with the suffix "ite" become "ous"
e.g. $H_2SO_3(aq)$ = sulfurous acid

prefixes "hypo" and "per" are kept: $HBrO_4$*(aq)* is perbromic acid.

Monovalent ions (ionic compounds)



Polyatomic ions

charge −1	charge −2	charge −3
NO_2^- nitrite	SO_3^{2-} sulfite	PO_3^{3-} phosphite
NO_3^- nitrate	SO_4^{2-} sulfate	PO_4^{3-} phosphate

chlorine		bromine		ionine	
ClO^-	hypochlorite	BrO^-	hypobromite	IO^-	hypoiodite
ClO_2^-	chlorite	BrO_2^-	bromite	IO_2^-	iodite
ClO_3^-	chlorate	BrO_3^-	bromate	IO_3^-	iodate
ClO_4^-	perchlorate	BrO_4^-	perbromate	IO_4^-	periodate

charge −1	
CN^-	cyanide
OCN^-	cyanate
SCN^-	thiocyanate
MnO_4^-	permanganate
$CH_3CO_2^-$	acetate
CO_3^{2-}	carbonate
OH^-	hydroxide

charge −2	
CrO_4^{2-}	chromate
$Cr_2O_7^{2-}$	dichromate
$S_2O_3^{2-}$	thiosulfate
$C_2O_4^{2-}$	oxalate
O_2^{2-}	peroxide

charge +1	
NH_4^+	ammonium

IUPAC numerical multiplier

1 = mono	4 = tetra	7 = hepta	10 = deca
2 = di	5 = penta	8 = octa	11 = undeca
3 = tri	6 = hexa	9 = nona	12 = dodeca

Addition of an hydrogen to any ion will reduce its charge by 1

ion	Systematic name	charge
CO_3^{2-}	carbonate ion	−2
HCO_3^-	hydrogen carbonate ion (bicarbonate)	−1

SO_4^{2-}	sulfate ion	−2
HSO_4^-	hydrogen sulfate ion (bisulfate)	−1

PO_4^{3-}	hydrogen phosphate ion	−3
HPO_4^{2-}	hydrogen phosphate ion (biphosphate)	−2
$H_2PO_4^-$	dihydrogen phosphate ion	−1

Trivial or common names

Trivial name are often used in the laboratory. These short and easy names, accepted by IUPAC, are often used for practical reason as substitute for the systematic name.

Formula	Systematic name	Trivial name
H_2O	dihydrogen monoxide	water
H_2O_2	dihydrogen dioxide	peroxide
NH_3	Nitrogen trihydride	ammonia
O_3	trioxygen	ozone
CaO	Calcium oxide	quicklime
Al_2O_3	Aluminum oxide	alumina
$Mg(OH)_2$	Magnesium oxide	milk of magnesia
$NaCl$	Sodium chloride	table salt
$MgSO_4$	Magnesium sulfate	Epsom salt
CH_4*	carbon tetrahydride	methane
C_6H_6*	Hexacarbon hexahydride	benzene

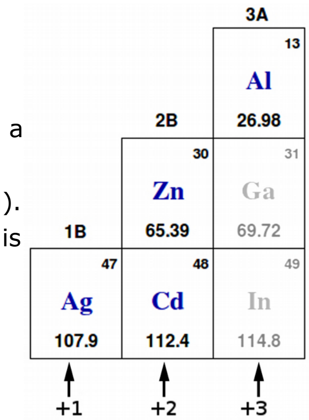
**A large number of organic compounds are named by their trivial names.*

The first 10 straight-chain alkanes $C_nH_{(2n+2)}$

Name	Formula
methane	CH_4
ethane	C_2H_6
propane	C_3H_8
butane	C_4H_{10}
pentane	C_5H_{12}

Name	Formula
hexane	C_6H_{14}
heptane	C_7H_{16}
octane	C_8H_{18}
nonane	C_9H_{20}
decane	$C_{10}H_{22}$

Naming compounds exceptions (what you need to know!)



Some transition metal (1B, 2B) are named without roman numbers.

Transition elements could have multiple valences (ex: Fe^{3+}, Fe^{2+}). Therefore, a roman number is essential to name them.
However, some transition metals do not have multiple valences (Ag, Zn, Cd). Therefore, in these cases, the roman number should not be used. Al ion is always +3.

Ex: Silver bromide: AgBr, Zinc chloride: $ZnCl_2$, Aluminum oxide: Al_2O_3.

Some covalent compound are named like ionic compounds.
CO, a covalent compound is named: carbon monoxide. HCl is also a covalent compound however, his name is not hydrogen monochloride. Any compound made up of an halogen bonded to an hydrogen are named like an ionic compound.

Ex. HF: Hydrogen fluoride, HCl: hydrogen chloride, etc.

Also, divalent elements N_2, O_2, F_2, Cl_2, etc. are simply named without the Latin "bi-" or "di-" prefix.
O_2 is oxygen not bioxygen or dioxygen. However, for an allotrope like O_3 the name trioxygen is acceptable but its common name "ozone" is preferred.

Oxide name correction
When a Latin word that precede the word "oxide" end-up with an "a", the letter "a" is removed.

Ex. P_2O_5 is diphosphorous pentoxide (not pentaoxide).

Mercury(I) alone does not exist
This metal has two possible oxidation states: +1 and +2. However, the mercury +1 ion never exist alone; it is always bounded to another mercury [Hg^+ — Hg^+] or Hg_2^{2+}. That is why, the mercury(I) chloride (also called calomel) is Hg_2Cl_2 not HgCl since the two mercury ions are "inseparables".

Peroxide
Peroxide is an ion made up of two oxygens: O_2^{2-}. The oxygen–oxygen chemical bond of peroxide is quite reactive, unstable and can easily be split. It is however "stable" in several covalent compounds and with some ionic compounds involving alkali and alkaline earth metals like Li_2O_2, MgO_2.
Confusion arises when peroxide combines with metal that could make multiple valence:

Ex: MnO_2 : manganese(iv) oxide or manganese(II) peroxide?

Naming a binary compound involving transition metal with peroxide is no considered since peroxide does not forms a stable compound. It could however be stable in coordination chemistry like $CrO(O_2)_2$ or $Na_2Ti_3O_7$, which are not simple binary compound anymore.

Suffix "-ic" and "-ous" are mostly used for naming acids.
The chemical industry is still using the suffix "-ic" and "-ous" to name ionic compounds. The high oxidation state cation is "-ic", and its low oxidation state is "-ous". However, it provides no information on the actual charge of the ion. e.g. $PbCl_4$ = plumbic chloride and plumbous chloride is $PbCl_2$

This method cannot be used for transition elements like vanadium and manganese which could have more than two oxidation states. Today the suffix "-ic" and "-ous" is mainly used to name acids.