Nomenclature Review and Extension

Binary Compounds

Rules:

1. Determine which element is the cation. The cations are usually found toward the left of the periodic table and are written first in the name and formula of a molecule.
2. Determine which element is the anion. The anions are non-metals (or hydrogen), located on the right side of the periodic table, and are written second in the name and formula of a molecule.
3. Write the cation first using the name of the element.
4. Write the anion second, dropping the usual ending and replacing it with "ide".

element	anion
fluorine	fluoride
chlorine	chloride
bromine	bromide
iodine	iodide
hydrogen	hydride

element	anion
oxygen	oxide
sulphur	sulphide
nitrogen	nitride
phosphorous	phosphide
carbon	carbide

Multiple Valences

Latin method – "ous/ic"

Many cations have more than one possible charge. The Latin method is the oldest method used to deal with this program, and while it can't be used for many molecules, it is still used in industry.

Rules:

1. Determine the charge on the cation.
2. Select the proper name for the cation.
   a) The "ous" ending refers to the lower cation charge.
   b) The "ic" ending refers to the higher cation charge.
3. Write the name of the anion as before, using the "ide" ending

element	higher charge		lower charge	
iron	+3	ferric	+2	ferrous
copper	+2	cupric	+1	cuprous
tin	+4	stannic	+2	stannous
antimony	+5	stibbic	+3	stibbous
		antimonic		antimonous

element	higher charge		lower charge	
gold	+3	auric	+1	aurous
mercury	+2	mercuric	+1	mercurous
lead	+4	plumbic	+2	plumbous
phosphorous	+5	phosphoric	+3	phosphorous

Prefix Method

This method is commonly used only for naming binary compounds composed of two non-metals.

1. A prefix is used to indicate the number of atoms in the molecule.

number of atoms	prefix
1	mono
2	di
3	tri
4	tetra
5	penta

number of atoms	prefix
6	hexa
7	hepta
8	octa
9	nona
10	deca

2. Place the appropriate prefix in front of the cation (mono is dropped in the first element).
3. Place the appropriate prefix in front of the anion, using the "ide" suffix as before.

Exceptions:

1. Peroxides – contain O_2^{-2} ion

   Peroxides have an extra oxygen atom. Write the formula for the ordinary oxide and add one additional oxygen atom. Peroxides are NOT reduced.

   barium oxide – BaO barium peroxide – BaO_2
   hydrogen oxide – H_2O hydrogen peroxide – H_2O_2

2. Diatomic Elements

   The following gaseous elements consist of two atoms joined together. They do not occur naturally as a single atom. (mnemonic – HOFBrINCl or Hey NO halogens)

   H_2 N_2 O_2 F_2 Cl_2 Br_2 I_2

IUPAC (Roman Numeral) Method

The IUPAC (International Union of Pure and Applied Chemists) method is a standardized nomenclature system that always works. The Roman Numerals are NOT used when there is only one possible positive valence (ie Columns I, II, III, Ag, Zn and Cd).

Rules:

1. Determine the charge on the anion (there is only one possibility).
2. Determine the total negative charge by multiplying the anion charge by the number of anions present.
3. The total positive charge equals the total negative charge in a neutral molecule.
4. Divide the total negative charge by the number of cations present to determine the charge on each cation.
5. Write down the name of the cation.
6. Write the charge on the cation using Roman Numerals in brackets after the cation.
7. Write down the name of the anion using the "ide" ending.

Compound Ions

Many ions consist of more than one element. These ions all have special names which you will not need to memorize. A chart of the compound ions will be provided to you for all tests and quizzes.

The charge given in the chart is the charge on the compound ion as a unit.

Compound molecules are named using the IUPAC system, the only difference being that if more than one of the compound ions is needed to form a neutral molecule, brackets are placed around the ion.

nitrate	NO_3^{-1}
fluorate	FO_3^{-1}
chlorate	ClO_3^{-1}
bromate	BrO_3^{-1}
iodate	IO_3^{-1}
carbonate	CO_3^{-2}
sulphate	SO_4^{-2}
phosphate	PO_4^{-3}

hydrogen carbonate (bicarbonate)	HCO_3^{-1}
hydrogen sulphate	HSO_4^{-1}
monohydrogen phosphate	HPO_4^{-2}
dihydrogen phosphate	$H_2PO_4^{-1}$

Compound Ion Variations

Relationship to Key Ion	**Compound Ion**	**Ion name**
One more oxygen atom	ClO_4^{1-}	**per**chlor**ate**
Key ion	ClO_3^{1-}	chlor**ate**
One less oxygen atom	ClO_2^{1-}	chlor**ite**
Two less oxygen atoms	ClO^{1-}	**hypo**chlor**ite**

The oxy ion variations are based on the compound ions in the previous section. Since the oxygen are attached by coordinate covalent bonds, the charge on the ion does not change as you add or subtract oxygens.

Additional Ions

OH^{1-}	hydroxide ion
MnO_4^{1-}	permanganate ion
NH_4^{1+}	ammonium ion
CrO_4^{2-}	chromate ion
$Cr_2O_7^{2-}$	dichromate ion
CN^{1-}	cyanide ion
SCN^{1-}	thiocyanate ion
$S_2O_3^{2-}$	thiosulphate ion
CH_3COO^{1-}	acetate ion

Binary Acids

Note: Some normally covalent (although very polar) compounds become ions when placed in water, and so are given special names when in their aqueous state.

If there is no "O", use hydro_ic acid. Notice how the charge is balanced with hydrogens and that the acid name is only used when the compound is aqueous.

Compound	**Name (g)**	**Acid name (aq)**
HF	hydrogen fluoride	hydrofluoric acid
HCl	hydrogen chloride	hydrochloric acid
HBr	hydrogen bromide	hydrobromic acid
HI	hydrogen iodide	hydroiodic acid
H_2S	hydrogen sulphide	hydrosulphuric acid

OXY Acids

Acids based on the common ion (with the charge balanced completely by adding hydrogens) are given the form _____ic acid. Similar names are given to acids with more or fewer oxygens.
Per___ate → per___ic acid, ___ite → ___ous acid, hyp___ite → hyp___ous acid

Oxy-acid (aq)	**Acid name**
HNO_3	nitric acid
$HClO_3$	chloric acid
$HBrO_3$	bromic acid
HIO_3	iodic acid
H_2CO_3	carbonic acid
H_2SO_4	sulphuric acid
H_3PO_4	phosphoric acid
CH_3COOH	acetic acid

Relationship to Key acid	**Acid (aq)**	**Acid name**
One more oxygen atom	$HClO_4$	**per**chlor**ic acid**
Key acid	$HClO_3$	chlor**ic acid**
One less oxygen atom	$HClO_2$	chlor**ous acid**
Two less oxygen atoms	HClO	**hypo**chlor**ous acid**

Hydrates

Hydrated ionic compounds have a specific number of water molecules in their chemical formula. In the solid, these water molecules are part of the compound's structure and are also known as "water of hydration". Name the ionic compound first then add the greek prefix to indicate the number of water molecules associated with the compound. A dot separates the compound from the waters of hydration.

e.g. $Ba(OH)_2 \cdot 8H_2O$ is called barium hydroxide octahydrate