

# AP Chemistry Ion Sheet -- Chemical Nomenclature

You have a choice: (a) You can memorize this list. (b) You can memorize some acid formulas and names and use them to predict the names and formulas of the polyatomic anions. In the following list: (a) The first name given is the IUPAC or Stock System name. (b) The second name is a traditional name.

## I. Monatomic Anions (-ide suffix):

hydride	H <sup>-1</sup>
fluoride	F <sup>-1</sup>
chloride	Cl <sup>-1</sup>
bromide	Br <sup>-1</sup>
iodide	I <sup>-1</sup>
astatide	At <sup>-1</sup>
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oxide	O <sup>-2</sup>
sulfide	S <sup>-2</sup>
selenide	Se <sup>-2</sup>
telluride	Te <sup>-2</sup>
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nitride	N <sup>-3</sup>
phosphide	P <sup>-3</sup>
arsenide	As <sup>-3</sup>
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carbide	C <sup>-4</sup>
silicide	Si <sup>-4</sup>

## II. Polyatomic Anions (-ite/-ate suffix)

### polyatomic anions with hydrogen:

hydrogen carbonate/bicarbonate	HCO <sub>3</sub> <sup>-1</sup>
hydrogen sulfate/bisulfate	HSO <sub>4</sub> <sup>-1</sup>
hydrogen sulfite/bisulfite	HSO <sub>3</sub> <sup>-1</sup>
monohydrogen phosphate	HPO <sub>4</sub> <sup>-2</sup>
dihydrogen phosphate	H <sub>2</sub> PO <sub>4</sub> <sup>-1</sup>
hydrogen oxalate/binoxalate	HC <sub>2</sub> O <sub>4</sub> <sup>-1</sup>
hydrogen phthalate/bipthalate	HC <sub>8</sub> H <sub>4</sub> O <sub>4</sub> <sup>-1</sup>

### polyatomic anions with sulfur:

thiocyanate	SCN <sup>-1</sup>
thiosulfate	S <sub>2</sub> O <sub>3</sub> <sup>-2</sup>

### monovalent polyatomic anions:

nitrate	NO <sub>3</sub> <sup>-1</sup>
nitrite	NO <sub>2</sub> <sup>-1</sup>

perchlorate	ClO <sub>4</sub> <sup>-1</sup>
chlorate	ClO <sub>3</sub> <sup>-1</sup>
chlorite	ClO <sub>2</sub> <sup>-1</sup>
hypochlorite	ClO <sup>-1</sup>

perbromate	BrO <sub>4</sub> <sup>-1</sup>
bromate	BrO <sub>3</sub> <sup>-1</sup>
bromite	BrO <sub>2</sub> <sup>-1</sup>
hypobromite	BrO <sup>-1</sup>

periodate	IO <sub>4</sub> <sup>-1</sup>
iodate	IO <sub>3</sub> <sup>-1</sup>
iodite	IO <sub>2</sub> <sup>-1</sup>
hypoiodite	IO <sup>-1</sup>

permanganate	MnO <sub>4</sub> <sup>-1</sup>
manganate	MnO <sub>3</sub> <sup>-1</sup>

cyanate	OCN <sup>-1</sup>
acetate	C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> <sup>-1</sup>
hydroxide	OH <sup>-1</sup>
cyanide	CN <sup>-1</sup>

### divalent polyatomic anions:

sulfate	SO <sub>4</sub> <sup>-2</sup>
sulfite	SO <sub>3</sub> <sup>-2</sup>

chromate	CrO <sub>4</sub> <sup>-2</sup>
chromite	CrO <sub>3</sub> <sup>-2</sup>
dichromate	Cr <sub>2</sub> O <sub>7</sub> <sup>-2</sup>

carbonate	CO <sub>3</sub> <sup>-2</sup>
oxalate	C <sub>2</sub> O <sub>4</sub> <sup>-2</sup>
phthalate	C <sub>8</sub> H <sub>4</sub> O <sub>4</sub> <sup>-2</sup>
peroxide	O <sub>2</sub> <sup>-2</sup>

### tri- and tetravalent polyatomic anions:

perborate	BO <sub>4</sub> <sup>-3</sup>
borate	BO <sub>3</sub> <sup>-3</sup>

phosphate	PO <sub>4</sub> <sup>-3</sup>
phosphite	PO <sub>3</sub> <sup>-3</sup>

arsenate	AsO <sub>4</sub> <sup>-3</sup>
arsenite	AsO <sub>3</sub> <sup>-3</sup>

silicate	SiO <sub>4</sub> <sup>-4</sup>
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# AP Chemistry Ion Sheet -- Chemical Nomenclature

You have a choice: (a) You can memorize this list. (b) You can learn to use the periodic chart to predict the positive charges of the metal and metalloid cations. In the following list: (a) The first name given is the IUPAC or Stock System name. (b) The second name is a traditional name.

## I. Monatomic Cations

### monovalent cations: (Table 8-1 and 8-2)

hydrogen	H <sup>+1</sup>
lithium	Li <sup>+1</sup>
sodium	Na <sup>+1</sup>
potassium	K <sup>+1</sup>
rubidium	Rb <sup>+1</sup>
cesium	Cs <sup>+1</sup>
francium	Fr <sup>+1</sup>

ammonium	NH <sub>4</sub> <sup>+1</sup>
silver	Ag <sup>+1</sup>
copper (I) or cuprous	Cu <sup>+1</sup>
gold (I) or aurous	Au <sup>+1</sup>
mercury (I) or mercurous (Hg <sup>+1</sup> ) in	Hg <sub>2</sub> <sup>+2</sup>

### divalent cations: (Table 8-1 and 8-2)

beryllium	Be <sup>+2</sup>
magnesium	Mg <sup>+2</sup>
calcium	Ca <sup>+2</sup>
strontium	Sr <sup>+2</sup>
barium	Ba <sup>+2</sup>
radium	Ra <sup>+2</sup>
zinc	Zn <sup>+2</sup>
cadmium	Cd <sup>+2</sup>
copper (II) or cupric	Cu <sup>+2</sup>
mercury (II) or mercuric	Hg <sup>+2</sup>
chromium (II) or chromous	Cr <sup>+2</sup>

manganese (II) or manganous	Mn <sup>+2</sup>
iron (II) or ferrous	Fe <sup>+2</sup>
cobalt (II) or cobaltous	Co <sup>+2</sup>
nickel (II) or nickelous	Ni <sup>+2</sup>
tin (II) or stannous	Sn <sup>+2</sup>
lead (II) or plumbous	Pb <sup>+2</sup>

### trivalent cations (Table 8-1 and 8-2)

aluminum	Al <sup>+3</sup>
gold (III) or auric	Au <sup>+3</sup>
chromium (III) or chromic	Cr <sup>+3</sup>
manganese (III) or manganic	Mn <sup>+3</sup>
iron (III) or ferric	Fe <sup>+3</sup>
cobalt (III) or cobaltic	Co <sup>+3</sup>
nickel (III) or nickelic	Ni <sup>+3</sup>
cerium (III) or cerous	Ce <sup>+3</sup>
arsenic (III) or arsenous	As <sup>+3</sup>
antimony (III) or antimonous	Sb <sup>+3</sup>
bismuth (III) or bismuthous	Bi <sup>+3</sup>

### tetra- & pentavalent cations (Table 8-2)

tin (IV) or stannic	Sn <sup>+4</sup>
lead (IV) or plumbic	Pb <sup>+4</sup>
cerium (IV) or ceric	Ce <sup>+4</sup>
arsenic (V) or arsenic	As <sup>+5</sup>
antimony (V) or antimonic	Sb <sup>+5</sup>
bismuth (V) or bismuthic	Bi <sup>+5</sup>

## Handout Table 8-2: Positive Ions Whose Charges Vary

IUPAC Name	root	Traditional Name		
		-ous ending	-ic ending	
copper (I) and (II)	cupr-	Cu+1	Cu+2	
gold (I) and (III)	aur-	Au+1	Au+3	
mercury (I) and (II)	mercur-	Hg <sub>2</sub> +2	Hg+2	
chromium (II) and (III)	chrom-	Cr+2	Cr+3	
manganese (II) and (III)	mangan-	Mn+2	Mn+3	
iron (II) and (III)	ferr-	Fe+2	Fe+3	
cobalt (II) and (III)	cobalt-	Co+2	Co+3	
nickel (II) and (III)	nickel-	Ni+2	Ni+3	
tine (II) and (IV)	stann-	Sn+2	Sn+4	
lead (II) and (IV)	plumb-	Pb+2	Pb+4	
cerium (III) and (IV)	cer-	Ce+3	Ce+4	
arsenic (III) and (V)	arsen-	As+3	As+5	
antimony (III) and (V)	antimon-	Sb+3	Sb+5	
bismuth (III) and (V)	bismuth-	Bi+3	Bi+5	

# AP Chemistry -- Acids and the Nomenclature of Ions

## I. Binary Acids and Monatomic Anions:

Binary Acids are those molecular compounds beginning with hydrogen and ending with another nonmetal or possibly a metalloid. Note that HCN, hydrocyanic acid is also included in this group. To make the acids into monatomic anions, remove the hydrogens -- one at a time. Each hydrogen removed leaves the anion with a -1 charge.

**Binary Acid Naming Rule** = *hydro* prefix - **root of 2nd element** -*ic* suffix *acid*

**Anion Naming Rule** = drop the prefix and the word acid, change the suffix to *-ide*

	<u>acid formula</u>	<u>acid name</u>	<u>ion formula</u>	<u>ion name</u>
<b>Examples:</b>	HF	hydrofluoric acid	F <sup>-1</sup>	fluoride
	HCl	hydrochloric acid	Cl <sup>-1</sup>	chloride
	HBr	hydrobromic acid	Br <sup>-1</sup>	bromide
	HI	hydroiodic acid	I <sup>-1</sup>	iodide
	HCN	hydrocyanic acid	CN <sup>-1</sup>	cyanide
	H <sub>2</sub> S	hydrosulfuric acid	HS <sup>-1</sup>	hydrogen sulfide or bisulfide
			S <sup>-2</sup>	sulfide
	HN <sub>3</sub>	hydrazoic acid	N <sub>3</sub> <sup>-1</sup>	azide

## II. Ternary Acids or Oxy-Acids:

Ternary acids contain three or more elements. They start with hydrogen, end with oxygen, and have another nonmetal or metalloid in between. To make the acids into polyatomic anions, remove the hydrogens -- one at a time. Each hydrogen removed leaves the anion with a -1 charge. Each ternary acid belongs to a family of potentially four members. One member of the family is designated the "**parent acid.**" You must **memorize** the names and formulas of the common parent acids.

### Ternary Acid Family Naming Rules:

HIO <sub>4</sub>	(add an oxygen to parent)	add <i>per-</i> prefix to parent name:	<b>periodic acid</b>
<b>** HIO<sub>3</sub> parent acid **</b>			<b>iodic acid</b>
HIO <sub>2</sub>	(remove one oxygen)	change suffix to <i>-ous</i> :	<b>iodous acid</b>
HIO	(remove a second oxygen)	add <i>hypo-</i> prefix to <i>-ous</i> name:	<b>hypoiodous acid</b>

**Anion Naming Rule** = drop the word acid  
change *-ic* suffix to *-ate*  
change *-ous* suffix to *-ite*

	<u>acid formula</u>	<u>acid name</u>	<u>ion formula</u>	<u>ion name</u>
<b>Examples:</b>	HIO <sub>4</sub>	periodic acid	IO <sub>4</sub> <sup>-1</sup>	periodate
	HIO <sub>3</sub>	iodic acid	IO <sub>3</sub> <sup>-1</sup>	iodate
	HIO <sub>2</sub>	iodous acid	IO <sub>2</sub> <sup>-1</sup>	iodite
	HIO	hypoiodous acid	IO <sup>-1</sup>	hypoiodite

(H<sub>3</sub>AsO<sub>4</sub> = arsenic acid H<sub>2</sub>AsO<sub>4</sub><sup>-1</sup> = dihydrogen arsenate HAsO<sub>4</sub><sup>-2</sup> = monohydrogen arsenate)

**III. Table 8-3: Common Parent Ternary Acids (Memorize these names and formulas!)**

carbonic acid	H <sub>2</sub> CO <sub>3</sub>	dichromic acid	H <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	cyanic acid	HOCN
boric acid	H <sub>3</sub> BO <sub>3</sub>	phosphoric acid	H <sub>3</sub> PO <sub>4</sub>	thiocyanic acid	HSCN
silicic acid	H <sub>4</sub> SiO <sub>4</sub>	arsenic acid	H <sub>3</sub> AsO <sub>4</sub>	oxalic acid	H <sub>2</sub> C <sub>2</sub> O <sub>4</sub>
nitric acid	HNO <sub>3</sub>	chloric acid	HClO <sub>3</sub>	phthalic acid	H <sub>2</sub> C <sub>8</sub> H <sub>4</sub> O <sub>4</sub>
sulfuric acid	H <sub>2</sub> SO <sub>4</sub>	bromic acid	HBrO <sub>3</sub>	acetic acid	HC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>
thiosulfuric acid	H <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	iodic acid	HIO <sub>3</sub>	sulfamic acid	H(NH <sub>2</sub> )SO <sub>3</sub>
chromic acid	H <sub>2</sub> CrO <sub>4</sub>	manganic acid	HMnO <sub>3</sub>		

**AP Chemistry -- Inorganic Nomenclature Rules****I. Binary Molecular Nomenclature**

These rules apply to molecular compounds of only two elements. To be classified molecular, the compound must begin with a nonmetal or metalloid.

**IUPAC Naming Rule:** cation name ( ) anion name [a Roman numeral is always included]

The first element in the formula is considered to be the cation and is named using the name of the nonmetal or metalloid present in the formula. Use the appropriate anion name (-ide, -ite, -ate) for the second element in the formula.

SO<sub>2</sub> = sulfur (IV) oxide                      SO<sub>3</sub> = sulfur (VI) oxide

**Traditional Naming Rule:** prefix (if > 1) cation name    prefix anion name

SO<sub>2</sub> = sulfur dioxide                      SO<sub>3</sub> = sulfur trioxide

**\*Special Case #1:** Binary Transition Metal Compounds (IIIB-VIIB) may be named by this molecular prefix rule once we have used up the traditional -ous and -ic cation suffixes.

Mn<sub>2</sub>O<sub>5</sub> = manganese (V) oxide (IUPAC) = dimanganese pentoxide (Traditional)

**\*Special Case #2:** Sometimes two different molecular compounds may have the same Roman Numeral in their IUPAC name. These formulas are always whole number multiples of some simplest formula. We resolve this by adding a third word indicating the multiple: dimer, trimer, tetramer, pentamer and so on.

NO<sub>2</sub> = nitrogen (IV) oxide    N<sub>2</sub>O<sub>4</sub> = nitrogen (IV) oxide dimer    N<sub>3</sub>O<sub>6</sub> = nitrogen (IV) oxide trimer

**Table of Standard Numerical Prefixes:**

mono-	1	octa-	8
di-	2	nona-	9
tri-	3	deca-	10
tetra-	4	undeca-	11
penta-	5	dodeca-	12
hexa-	6	trideca-	13
hepta-	7	tetradeca-	14

## II. Ionic Nomenclature

These rules apply to ionic compounds of only two or more elements. To be classified ionic, the compound must begin with a metal or metalloid.

**IUPAC Naming Rule:** cation name ( ) anion name

[The cation Roman Numeral is used **only** if more than one cation charge is possible! If there is only one charge -- **DON'T** use a Roman Numeral]

The first element in the formula is the cation and is named using the name of the respective element. Use the appropriate anion name (-ide, -ite, -ate) for the second element in the formula.

$\text{CaCl}_2$  = calcium chloride

$\text{FeCl}_2$  = iron (II) chloride

**Traditional Naming Rule:** cation root name with -ous or -ic suffix anion name

This is used only if the cation has more than one charge. The cation of lower charge is assigned the -ous suffix, the cation of higher charge is assigned the -ic suffix.

$\text{Ce}(\text{NO}_3)_3$  = cerous nitrate

$\text{Ce}(\text{NO}_3)_4$  = ceric nitrate

**\*Special Case #3:** Hydrated Ionic Compounds may be named by this rule to show the amount of water present. This may be used with both IUPAC and Traditional names. Name the cation with ( ) or -ous/-ic suffixes, name the anion, add to the name **numeric prefix-hydrate** to show the correct number of waters.

$\text{CuSO}_4 \cdot 5 \text{H}_2\text{O}$  = copper (II) sulfate pentahydrate or cupric sulfate pentahydrate