

NM												-3		-2		-1		NM
+1	+2											md	NM	NM	NM	NM	NM	NM
+1	+2											+3	md	NM	NM	NM	NM	NM
+1	+2											+2	md	md	NM	NM	NM	
+1	+2										+1		md	md	NM	NM	NM	
+1	+2															md	NM	
+1	+2																	

NM = nonmetal
 md = metalloid

Type I Binary Ionic Compounds

Type I binary ionic compounds contain a metal and a nonmetal AND the metal that is present only forms one type of cation. Metals with only one cation (shaded below with charges). Both the metal and the nonmetal form ions, which is why it is called an ionic compound.

- 1) From the following list, cross out those compounds that do NOT belong in the category for Type I binary ionic compounds.

NaCl ~~FeCl₂~~ CaCl₂ ~~TiO₂~~ MgO AlBr₃ KCl K₂S BeF₂ ~~Cu₂O₃~~ AgCl Zn₃N₂

Formula and name examples for Type I binary ionic compounds:

KI = potassium iodide BaO = barium oxide ZnF₂ = zinc fluoride Na₂S = sodium sulfide
 Ag₃N = silver nitride BeCl₂ = beryllium chloride

- What type of element is always listed first (metal or nonmetal)? Metal second? non-metal
- Is the name of the first element in the compound different from the element? (yes/no)
- What is the common ending for all the names? -ide
- In zinc fluoride, there are 2 fluoride atoms, are they indicated in the name? (yes/no)
- What is the charge on the zinc ion? 2+
- What is the charge on the fluoride ion? 1-
- Why do you need one zinc ion and two fluoride ions for the formula for zinc fluoride? to balance charges
- Why do you need two sodium ions for every sulfide ion in sodium sulfide?
Sodium is 1+ 3 S is 2- ∴ need to balance charge.
- As a team, determine the rules for naming type I binary ionic compound when given the formula.
 ① name metal
 ② use root + ide
- As a team, determine the rules for writing the formula for a type I binary compound when given the name.
 ① Symbol for metal
 ② Symbol for non-metal (⊖ ion)
 ③ Cross charges for correct subscripts for each atom.

12) Name each of the type I binary ionic compounds listed in question 1.

Sodium chloride

potassium sulfide

Calcium chloride

Beryllium fluoride

Magnesium oxide

Silver chloride

Aluminum bromide

Zinc Nitride

Potassium chloride

Type II Binary Ionic Compounds

Type II binary ionic compounds also contain a metal and a nonmetal however the metal that is present here can form more than one type of cation. Metals with multiple possible charges are listed in the periodic table as blank. Type II metals are NOT Type I metals. Again, both the metal and the nonmetal form ions, and it is still called an ionic compound. These metals usually only form two different ions.

1) From the following list, cross out those compounds that do NOT belong in the category for Type II binary ionic compounds.

~~AlP~~ FeCl₂ ~~Ag₂O~~ VBr₅ CoS SnF₂ ~~K₃N~~ ~~SrF₂~~ CuBr AuCl₃ ~~ZnO~~ HgS

Formula and name examples for Type II binary ionic compounds:

Fe₂O₃ = iron(III) oxide or ferric oxide

FeO = iron(II) oxide or ferrous oxide

CuS = copper(II) sulfide or cupric sulfide

CuCl = copper(I) chloride or cuprous chloride

MnO₂ = manganese(IV) oxide or manganic oxide

MnCl₂ = manganese(II) chloride or manganous chloride

- 2) What type of element is always listed first (metal or nonmetal)? metal second? non-metal
- 3) Is the name of the first element in the compound different from the element? (yes/no)
- 4) What is the common ending for the nonmetal portion of the names? -ide
- 5) In the compound FeO, what is the charge on iron? 2+
- 6) In the compound Fe₂O₃, what is the charge on iron? 3+
- 7) What does the Roman number after the metal name represent? charge of metal
- 8) When the metal name ends in -ic, to what ion does it refer? (higher charge/lower charge)
- 9) When the metal name ends in -ous, to what ion does it refer? (higher charge/lower charge)
- 10) As a team, determine the rules for naming type II binary ionic compound when given the formula.
① name metal using latin system or stock system (roman numeral)
② name negative ion.
- 11) As a team, determine the rules for writing the formula for a type II binary compound when given the name.
① write symbol for \oplus ion (metal)
② write negative ion
③ cross charges to cancel charges & set subscript.
- 12) Name each of the type II binary ionic compounds listed in Question 1 of Type II section.

ferrous
iron (II) chloride

cuprous
copper (I) bromide

Vanadium (V) Bromide

gold (III) chloride

Cobalt (II) Sulfide

mercuric
mercury (II) sulfide

stannous
tin (II) fluoride

Type III Binary Compounds

Binary compounds that do not contain metals have covalent bonds instead of ionic bonds. A covalent bond is formed by sharing one or more pairs of electrons. The pair of electrons is shared by both atoms. For example, in forming H₂, each hydrogen atom contributes one electron to the single bond.

- 1) From the following list, cross out those compounds that do NOT belong in the category for binary compounds containing only nonmetals or metalloids.



Formula and name examples for Type III binary ionic compounds:



Prefix	Meaning
Mono-	1
Di-	2
Tri-	3
Tetra-	4
Penta-	5
Hexa-	6
Hepta-	7
Octa-	8
Nona-	9
Deca-	10

- Which element is listed first in the name?
- Is the name of the first element in the compound different from the element? (yes/no)
- What is the common ending for all the names? _____
- What do the prefixes (di-, mono-, penta-, tri-) in the names above mean?
- Is the prefix mono- used when there is only one atom of the first element? (yes/no) Is the prefix mono- used when there is one atom of the second element? (yes/no)
- As a team, determine the rules for naming type III binary ionic compound when given the formula.

- 8) Name each of the type III binary compounds listed above.

Carbon tetrachloride tetraphosphorus decaoxide
Carbon monoxide Selenium trioxide
Selenium hexafluoride dinitrogen pentoxide
Silicon dioxide

Compounds Containing Polyatomic Ions

Polyatomic ions are ions that as a group have a set charge. Polyatomic ions are usually recognized in a formula by the grouping of more than one nonmetal elements after a metal. Your book has a table listing polyatomic ions. Use your book's table to fill in the following table with the appropriate names/formulas of the polyatomic ions.

Name	Formula	Name	Formula
ammonium	NH ₄ ⁺	chlorite	ClO ₂ ⁻
nitrate	NO ₃ ⁻	Acetate	C ₂ H ₃ O ₂ ¹
nitrite	NO ₂ ¹	chromate	CrO ₄ ²
hydroxide	OH ¹	carbonate	CO ₃ ²⁻
cyanide	CN ⁻	Sulfite	SO ₃ ²

Polyatomic ions containing oxygen (oxyanions) are somewhat special.

carbonate = CO_3^{2-}

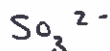
- 1) Match the location of carbon on the periodic table with the two figures on the right.
- 2) What number is in the carbon location on the left figure? To what does this number refer?
3 - # of oxygen
- 3) What number is the carbon location on the right figure? To what does this number refer?
2 - the charge of ion.
- 4) What element must all oxyanions contain?
oxygen
- 5) What is the ending of the name of the ion determined from these tables?
-ate
- 6) Determine the formula for the following oxyanions using the figures above. Phosphate PO_4^{3-}
Silicate SiO_4^{4-} Bromate BrO_3^- Iodate IO_3^- Sulfate SO_4^{2-} Nitrate NO_3^-

Tool for remembering oxy-anions

The left periodic table shows the number of oxygen atoms in oxy-anions ending in -ate. The number 3 is written in the carbon position (Group 14, Period 2). The right periodic table shows the charge on the oxy-anion ending in -ate. The number 2 is written in the carbon position.

perchlorate = ClO_4^- chlorate = ClO_3^- chlorite = ClO_2^- hypochlorite = ClO^-

- 7) When comparing the oxyanions above, is the charge of the chlorate ion the same as the charge for the other chloro-oxyanions?
YES
- 8) How many less oxygen atoms does chlorite have compared to chlorate?
1 ClO_2^-
- 9) How many more oxygen atoms does perchlorate have compared to chlorate?
1 ClO_4^-
- 10) How many less oxygen atoms does hypochlorite have compared to chlorate?
2
- 11) What name ending(s) can help you identify the presence of an oxyanion in a compound?
-ite or -ate
- 12) If sulfate is SO_4^{2-} , what would the formula for sulfite be?



13) In the table below, fill in the name and formula for the oxyanions in the shaded column. Use the figures on the previous page

14) In the table below, fill in the name and formula for the rest of the oxyanions.

Element	per-___-ate ion	___-ate ion	___-ite ion	hypo-___-ite ion
Bromine (Br)	perbromate BrO_4^-	bromate BrO_3^-	bromite BrO_2^-	hypobromite BrO^-
Iodine (I)	periodate IO_4^-	iodate IO_3^-	iodite IO_2^-	hypoiodite IO^-
Phosphorus (P)		phosphate PO_4^{3-}	phosphite PO_3^{3-}	
Nitrogen (N)		nitrate NO_3^-	nitrite NO_2^-	

Use your knowledge of Type I and Type II metals as well as the appropriate polyatomic name/formula to fill in the following table.

Name	Formula	Name	Formula
sodium carbonate	Na_2CO_3	Copper (II) nitrite cupr. 2	$\text{Cu}(\text{NO}_2)_2$
iron(II) nitrate	$\text{Fe}(\text{NO}_3)_2$	calcium sulfate	CaSO_4
Manganese (II) sulfate	MnSO_4	ammonium nitrate	NH_4NO_3
Calcium hypochlorite	$\text{Ca}(\text{ClO})_2$	potassium cyanide	KCN

Check your work:

Were the polyatomic ions correctly identified for the above table? Remember when you have parentheses, you must identify the polyatomic ions by looking inside the parentheses and the numbers outside the parentheses just indicate how many of that polyatomic ion you have.

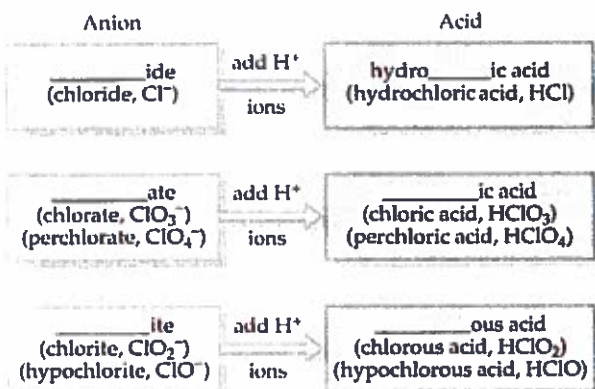
Are the compound formulas you filled into the table above neutral in charge? **Yes.**

Do all type II metals in the table above have their charge indicated by either a Roman numeral or their Latin name with an -ous or -ic ending? **Yes**

Are all type I metals listed without a Roman numeral? **Yes**

Acids

Acids are compounds that when dissolved in water, produce hydrogen ions (H^+). Naming acids can also be tricky. Use the following chart and try to classify each acid below to an area on the chart.



Given that the ion formula is NO_2^- , how can one determine the name of the ion, acid formula, and acid name?

Ion name:

- 1) Based on the -ate determination figures, what is the formula for nitrate? Is NO_2^- the nitrate ion or the nitrite ion?

Acid formula:

- 2) According to the figure above, what must be added to create an acid? What is the charge of the ion?
- 3) How many of the hydrogen ions must be added to NO_2^- to make a neutral acid (zero charge)?
- 4) What is the acid formula for the acid created when hydrogen ion(s) are added to NO_2^- ?

Acid name:

- 5) Based on your answer to Question 1 above, does the name for the NO_2^- ion end in -ite or -ate?
- 6) Use the figure above to determine how the name changes when we have the compound HNO_2 . Name the acid, HNO_2 .

Fill in the following table:

Acid Formula	Acid Name	Ion Formula	Ion Name
HCl	hydrochloric acid	Cl^-	chloride
HNO_3	nitric acid	NO_3^-	nitrate
H_2SO_4	sulfuric acid	SO_4^{2-}	sulfate
$HBrO_3$	bromic acid	BrO_3^-	bromate
H_3PO_4	phosphoric acid	PO_4^{3-}	phosphate
HBr	hydrobromic acid	Br^-	bromide
H_2CO_3	carbonic acid	CO_3^{2-}	carbonate
$HC_2H_3O_2$	acetic acid	$C_2H_3O_2^-$	Acetate

<http://serc.carleton.edu/sp/pkal/mnscu/activities/38478.html>