Naming Ionic Compounds

- Recall that an *ionic compound* is formed when a positive ion (usually a metal ion) is attracted and bonded to a negative ion (usually a non-metal ion). opposite charges attract
- We can use our knowledge of electron dot diagrams to understand the rules for naming different types of ionic compounds
    - Recall how the electron dot diagrams illustrated how every ionic compound is electrically neutral
- There are 3 different types of ionic compounds we need to know how to name
    1. *Binary ionic compounds* contain only two different types of elements and each ion has only one possible charge.
    2. *Polyatomic ionic compounds* contain more than two different types of elements and usually have a name ending with *–ite* or *–ate* (exceptions include hydroxide, ammonium, and cyanide)
        - A **polyatomic ion** is a group of atoms that are bonded together to take on a single overall charge. Polyatomic ions can be both negatively charged or positively charged.

Table of Common Polyatomic Ions

acetate (ethanoate)	CH_3COO^-	chromate	CrO_4^{2-}	phosphate	PO_4^{3-}
ammonium	NH_4^+	dichromate	$Cr_2O_7^{2-}$	hydrogen phosphate	HPO_4^{2-}
benzoate	$C_6H_5COO^-$	cyanide	CN^-	dihydrogen phosphate	$H_2PO_4^-$
borate	BO_3^{3-}	hydroxide	OH^-	silicate	SiO_3^{2-}
carbide	C_2^{2-}	iodate	IO_3^-	sulfate	SO_4^{2-}
carbonate	CO_3^{2-}	nitrate	NO_3^-	hydrogen sulfate	HSO_4^-
hydrogen carbonate	HCO_3^-	nitrite	NO_2^-	sulfite	SO_3^{2-}
perchlorate	ClO_4^-	oxalate	$OOCCOO^{2-}$	hydrogen sulfite	HSO_3^-
chlorate	ClO_3^-	hydrogen oxalate	$HOOCCOO^-$	hydrogen sulfide	HS^-
chlorite	ClO_2^-	permanganate	MnO_4^-	thiocyanate	SCN^-
hypochlorite	OCl^- or ClO^-	peroxide	O_2^{2-}	thiosulfate	$S_2O_3^{2-}$
		persulfide	S_2^{2-}		

3. *Multivalent ionic compound* contains at least one element that has more than one common charge (ie. Cu^+ and Cu^{2+})

Ionic (Binary)

STEPS: Name to Formula

magnesium chloride

i. Write the symbol of the elements with their charge.

Mg^{2+} Cl^-

ii. Every compound needs to be neutral (ie. has an overall charge of zero). If charges are unbalanced, add more of either the positive or negative ion to balance out the charge.

Mg^{2+} Cl^- Cl^-

iii. Now count how many of each element you have and write them as subscripts behind each element. Remember, the number one is implied; you don't write it down.

$MgCl_2$ * don't write down the charges at this point!

STEPS: Formula to Name

CaO

i. Find the name of the first symbol and write it down.

Calcium

ii. Find the name of the second element and change the ending to -ide. Leave a space between the first name and the second.

Calcium oxide

Ionic (Polyatomic)

STEPS: Name to Formula

iridium sulfite

i. Write the symbol of the elements with their charge.

Ir^{4+} SO_3^{2-}

ii. Every compound needs to be neutral (ie. has an overall charge of zero). If charges are unbalanced, add more of either the positive or negative ion to balance it out.

Ir^{4+} SO_3^{2-} SO_3^{2-}

iii. Now count how many of each element you have and write them as subscripts behind each element. Remember, the number one is implied; you don't write it down. If you have more than one polyatomic ion, brackets need to go around the polyatomic ion.

$Ir(SO_3)_2$

STEPS: Formula to Name

K_2SO_4

i. Find the name of the first symbol and write it down.

potassium

ii. Find the name of the polyatomic ion and write it down. Leave a space between the first name and the second.

potassium sulphate

Ionic (Multivalent)

STEPS: Name to Formula

iron(III) oxide

i. Write the symbol of the first element with its charge. Remember, when it is multivalent, the charge for the metal is indicated in roman numerals.

Fe^{3+}

ii. Write the symbol of the second element with its charge.

Fe^{3+} O^{2-}

iii. Every compound needs to be neutral (ie. has an overall charge of zero). If charges are unbalanced, add more of either the positive or negative ion to balance it out.

Fe^{3+} Fe^{3+} O^{2-} O^{2-} O^{2-}

iv. Now count how many of each element you have and write them as subscripts behind each element. Remember, the number one is implied; you don't write it down.

Fe_2O_3

STEPS: Formula to Name

MnO_2

i. Write the symbol of the second element with its appropriate negative charge.

O^{2-}

ii. Multiply the second element's negative charge by how many atoms are in the compound (indicated by the subscript number following the second element).

$(-2) \times 2 = -4$

iii. Remember that compounds need to be neutral. So the total negative charge from the second element needs to equal the total positive charge from the first element. Write this total positive charge down.

$+4$

iv. Divide the total positive charged by how many first elements are in the compound (indicated by the subscript).

$+4 \div 1 = +4 \therefore Mn^{4+}$

v. This is the correct charge for the first element. Write the name of the first element with the corresponding Roman numeral for its charge in brackets.

manganese (IV)

vi. Write the name of the second element, changing the ending to -ide.

manganese (IV) oxide

Practice Problems

1. Complete the chart below for all binary ionic compounds.

Formula	IUPAC Name
$ZnCl_2$	Zinc chloride
KI	potassium iodide
MgO	magnesium oxide
$AlCl_3$	aluminum chloride
LiCl	lithium chloride
Al_2O_3	aluminium oxide
$CdCl_2$	cadmium chloride
$CaCl_2$	calcium chloride
NaCl	sodium chloride
ZnO	zinc oxide
AgI	silver iodide
MgH_2	magnesium hydride
$MgCl_2$	magnesium chloride
Sr_3N_2	strontium nitride
Ag_2S	silver sulphide
KCl	potassium chloride
CaF_2	calcium fluoride
Sc_2O_3	scandium oxide
ZnS	zinc sulphide

2. Complete the chart below for all polyatomic ionic compounds.

Formula	Name
Na_2CO_3	sodium carbonate
$(NH_4)_2CO_3$	ammonium carbonate
$CaSO_4$	calcium sulphate
$LiOH$	lithium hydroxide
$Al(OH)_3$	aluminum hydroxide
$NaClO$	sodium hypochlorite
$K_2Cr_2O_7$	potassium dichromate
$NaNO_2$	sodium nitrite
$(NH_4)_2SO_4$	ammonium sulphate
$Mg(HCO_3)_2$	magnesium hydrogen carbonate
Na_3PO_4	sodium phosphate
$CaHPO_4$	calcium hydrogen phosphate
$LiCrO_4$	lithium chromate
$NaHSO_3$	sodium hydrogen sulfite
$KMnO_4$	potassium permanganate
$Al_2(SiO)_3$	aluminum silicate
Li_2CO_3	lithium carbonate
KCN	potassium cyanide
$NH_4H_2PO_4$	ammonium dihydrogen phosphate

3. Complete the chart below for all multivalent ionic compounds.

Formula	Name
Fe_2O_3	iron(III) oxide
PbS	lead(II) sulphide
Hg_2O	mercury(I) oxide
FeS	iron(II) sulphide
HgF_2	mercury fluoride
$TiCl_3$	titanium(III) chloride
$CoBr_2$	cobalt(II) bromide
PbO_2	lead(IV) oxide
Sb_2O_5	antinomy(V) oxide
PdI_2	palladium(II) iodide
$CrCl_2$	chromium(II) chloride
CuCl	copper(I) chloride
BiI_3	bismuth(III) iodide
MnO_2	manganese(IV) oxide
$BiCl_5$	bismuth(V) chloride
Au_2S	gold(I) sulphide
$SbCl_3$	antinomy(III) chloride
Pb_2S_5	lead(IV) sulphide
CuS	copper(II) sulphide
$SnBr_2$	tin(II) bromide