2.5 C3 Multivalent Metals

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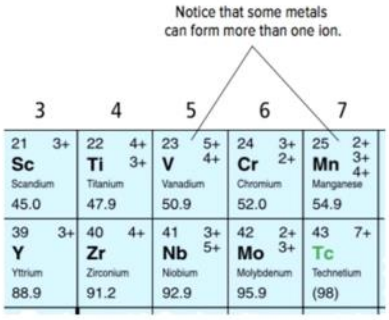
Science 9- Chemistry Topic 2.5 - Concept 3: Multivalent metals form more than one ion. (Read pages 162-163)



Multivalent metals – metals that form more than one ion.

e.g. copper can form ions with 2+ or 1+ charge.

- To distinguish between the ions a Roman numeral is written after the name of the metal.

e.g. Copper (I) or Copper (II) Cu^{1+} Cu^{2+}

**Are all transition metals multivalent?* No

Naming and writing formulas for Ionic compounds containing multivalent metals.

- When writing the formula for a multivalent metal follow the same process as for the binary compounds
- Since you can't tell the charge on the metal just by looking at the periodic table you should look at the Roman numeral in the name

e.g. chromium (III) tells you that the chromium ion compound is Cr^{3+}

Metal Ion Charge	Roman Numeral	Metal Ion Charge	Roman Numeral
1+	I	5+	V
2+	II	6+	VI
3+	III	7+	VII
4+	IV	8+	VIII

Writing Formulas

Steps	chromium(III) chloride
1. Identify each Ion and its charge.	Cr^{3+} Cl^{-}
2. Determine the numbers of Ion needed to balance positive charges with negative charges.	Cr^{3+} Cl^{-} Cl^{-} Cl^{-} Cr_1Cl_3
3. Use subscripts to write the formula. Remember to write the metal ion first.	$CrCl_3$

Writing Formulas using "Criss-Cross" Method

Sn^{4+} or Sn^{2+} Tin(II)

Steps	Iron(III) nitride	tin(IV) oxide
1. Write the formula of the positive ion first, and the negative ion second. In the given name, the positive ion name is always written first, and negative ion name is written second.	Fe^{3+} N^{3-}	Sn^{4+} O^{2-}
2. "**Criss-cross**" the numbers in front of the **charges** on the ions. If **no number** is shown, use a **1**. The purpose of criss-crossing to make the overall + ion charge equal to the overall – ion charge.	Fe_3N_3 ÷3 reduce	Sn_2O_4 ÷2
3. "Clean-up" the formula, in 3 small steps a) Omit the superscript charges and numbers b) If possible **reduce** subscript by dividing by common number (usually 2) c) Omit any subscript which is a 1.	FeN	SnO_2

Practice Problems: Chemical Formula Writing

Name of Compound	Ions	Formula
nickel(II) chloride	Ni^{2+} Cl^{-}	
copper(I) sulfide	Cu^{1+} S^{2-}	
lead(IV) iodide	Pb^{4+} I^{1-}	
tin(IV) fluoride	Sn^{4+} F^{1-}	
mercury(I) bromide	Hg^{1+} Br^{1-}	
copper (II) oxide	Cu^{2+} O^{2-}	
chromium(III) selenide	Cr^{3+} Se^{2-}	
gold(I) iodide	Au^{1+} I^{1-}	
manganese(II) nitride	Mn^{2+} N^{3-}	
cobalt(III) phosphide	Co^{3+} P^{3-}	
iron(III) chloride	Fe^{3+} Cl^{-}	
lead(II) bromide	Pb^{2+} Br^{1-}	
tin(IV) iodide	Sn^{4+} I^{1-}	
mercury(II) fluoride	Hg^{2+} F^{1-}	
platinum(IV) oxide	Pt^{4+} O^{2-}	
manganese(III) chloride	Mn^{3+} Cl^{-}	
chromium(II) nitride	Cr^{2+} N^{3-}	
gold(III) sulfide	Au^{3+} S^{2-}	
cobalt(II) phosphide	Co^{2+} P	
iron(II) selenide		
mercury(I) sulfide		
gold(III) bromide		
bismuth(V) hydride		
uranium(VI) phosphide		

Name: _____ Date: _____

Science 9- Chemistry Topic 2.5 - Concept 3: Naming Compounds with Multivalent ions. (Read pages 162-163)

Steps	Fe_2O_3	SnS_2
1. Identify the Ion.	Fe^{3+} O^{2-}	Sn^{4+} S^{2-}
2. Determine the ratio of ions in the compound.	Fe^{3+} O^{2-}	S^{2-}
3. The positive charges and negative charges must be equal in magnitude for the compounds to be electrically neutral.	$\overline{6+} = \overline{6-}$	$\overline{+4}$ $\overline{4-}$
4. Write the name of the compound using a Roman numeral to indicate the charge of the metal ion.	Iron (III) Oxide	Tin (IV) Sulfide

Naming Compounds using the "Reverse Criss-Cross" Method

Steps	K_2S_1	MnS
1. "Un-criss-cross" the subscripts back into the superscripts with charges.	K_2S_1	$Mn_1S_1 \rightarrow Mn_2S_2$
2. Then look at the **NON-METAL ION CHARGE** after the "un-criss-cross", if it is **NOT CORRECT**, then **multiply** the superscripts by the proper number so the non-metal ion ends up with the right charge. The resulting charge on the metal ion is now correct!	K^{1+} S^{2-} ↖ see if this exist !!	Mn^{1+} S^{1-} → wrong charge !! ↓ Mn^{2+} S^{2-} Real
3. Write the name of the compound.	Potassium Sulfide ↑ only 1 type	Manganese (II) Sulfide

Formula	Name of Compound	Formula	Name of Compound
MnS		AuBr	
$PbBr_2$ Pb^{2+} Br^-	Lead (II) Bromide	PtO	
Pb_3N_2		Fe_2S_3	
Au_2O_3		SnO	
FeI_2		$PbCl_2$	
Sn_3P_4		PbO_2	
Cu_2S		Cu_2O	
$SnCl_2$		FeSe	
NiP Ni^+ P^{1-} → Ni^{3+} P^{3-}	Nickel (III) phosphide	PtO_2	
CrF_3		CuO	
$CuCl_2$		NiF_2	

Which method do you prefer? _____