

Outcome 1
Topic 3 - Ionic Compounds

How Atoms Bond
<http://www.youtube.com/watch?v=NjD9yHsJ29I&app=desktop>

- Two types of compounds we will study in Science 10 are:
 - a. Ionic Compounds - are formed between a cation and anion
 - b. Molecular compounds - are formed between non-metal atoms
- Ionic compounds are **neutral** and **stable** compounds
- Ionic compounds are formed through the process of **ionic bonding**.
- Ionic bonds form between ~~atoms~~ ^{metal} **metals** and ^{non-metal} **non-metals**.
- They are formed whenever electrons are transferred from a metal atom to a non-metal atom.

<http://bcs.whfreeman.com/thelifewire/content/chp02/02020.html>

http://www.teachersdomain.org/asset/lps07_int_ionicbonding/

http://www.bbc.co.uk/schools/gcse/bitesize/science/add_aqa/atomic/ionicrev4.shtml

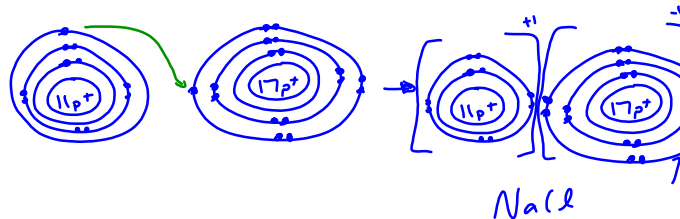
- There are many different ways that ionic compounds can form
 - a. A univalent metal cation + a simple non-metal anion
 - b. A multivalent metal + a simple non-metal anion
 - c. Compounds formed with polyatomic cations and/or anions

A. A univalent metal cation + a simple non-metal anion

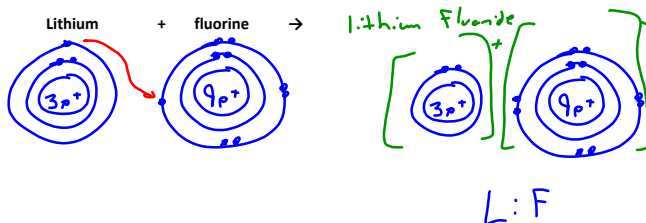
- Univalent means - **an element that has only one possible ion form**
 - i. E.g. Sodium has only one ion - Na⁺

simple metal + simple non-metal → ionic compound

Sodium + chlorine → sodium chloride



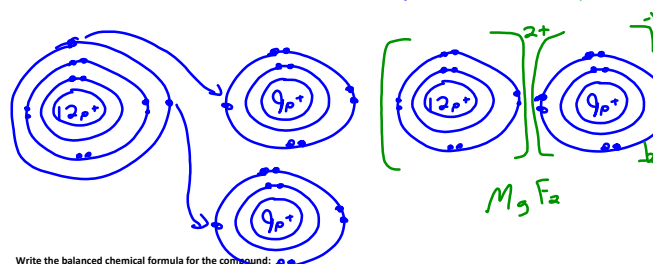
Example 2:



Write the balanced chemical formula for the compound:

Example 3:

Word Formula: Magnesium + ~~Bromine~~ ^{fluorine} → ^{magnesium} ~~fluoride~~



Write the balanced chemical formula for the compound:

Naming Ionic Compounds:

- All ionic compounds are made of two parts: **a cation and an anion**
- Therefore names of ionic compounds also have two parts:
 - Name the cation first by using the elements name (usually a metal)
 - Name the anion second by changing the ending of the elements name to **ide**

Formula	Cation	Anion	Name
NaCl	Na ⁺	Cl ⁻	
BaF ₂	Ba ²⁺	F ⁻	
K ₃ N	K ⁺	N ³⁻	

Predicting Ionic Compound Formula

- The formula for an ionic compound contains element symbols that identify the type of ion present in the compound
 - Ex. NaCl - tells us that there is sodium and chloride ions present in the compound
- The formula may also have number subscripts that tells us how many of each ion makes up the compound.
 - Ex. BaF₂ - tells us that there is 2 fluoride atoms and only 1 barium atom in the compound
- All ionic compounds are composed of an **equal number of positive and negative charges.**
 - Therefore the total charge of the cations must equal the total charge of the anions.

Steps	Examples	
	Sodium chloride	Aluminum chloride
1. Identify ions and their charges	Na ⁺ Cl ⁻	Al ⁺³ Cl ⁻
2. Determine the total charges needed to balance	Na ⁺ Cl ⁻	Al ⁺³ Cl ⁻ Cl ⁻ Cl ⁻
3. Note the ratio of <u>cations</u> to anions	1 : 1	1 : 3
4. Use subscripts to write the formula if necessary	Na Cl	AlCl ₃

<http://www.chemfiles.com/flash/formulas.html>



	Name	Formula
a) silver and iodine	silver iodide $Ag^+ I^-$	$AgI(s)$
b) magnesium and oxygen	magnesium oxide $Mg^{2+} O^{2-}$	MgO
c) magnesium and bromine	magnesium bromide $Mg^{2+} Br^-$	$MgBr_2$
d) calcium and nitrogen	calcium nitride	Ca_3N_2
e) zinc and selenium	zinc selenide	$ZnSe$
f) sodium and sulfur	sodium sulfide	Na_2S
g) barium and phosphorus	barium phosphide	Ba_3P_2
h) aluminium and fluorine	aluminium fluoride	AlF_3
i) potassium and chlorine	potassium chloride	KCl
j) silver and oxygen	silver oxide	Ag_2O

a) MgCl_2	magnesium chloride	
b) Ag_3N	silver nitride	
c) CsF	cesium fluoride	
d) CdO	cadmium oxide	
e) MgBr_2	magnesium bromide	
f) Al_2O_3	aluminum oxide	
g) NaI	sodium iodide	
h) K_2S	potassium sulfide	
i) BaS	barium sulfide	
j) Li_3P	lithium phosphide	

Compounds formed with multivalent metals

○ **Multivalent metals** - a metal that has more than one possible ion that can form from the atom.

○ Ex. Irons can exist in two forms: iron³⁺(III) and iron²⁺(II)... The Roman numerals tell you the charge on the ion and which one should be used in the chemical formula.

○ There are two types of problems you will run into when using multivalent metals.

1. Determining the name of a compound from the chemical formula. SnO_2

2. Writing the chemical formula from the name tin(IV) oxide

1. Determining the name of a compound from the chemical formula

Example 1: Write the word formula for ... FeO

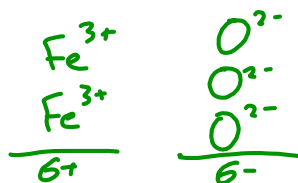
iron(II) oxide



Roman numerals tell us the charge on the cation and must be included in the word formulas.

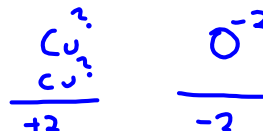
Example 2: Write the word formula for Fe₂O₃

iron(III) oxide



Example 3: Write the word formula for Cu₂O

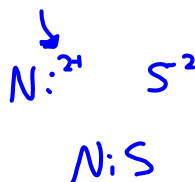
copper(I) oxide



2. Writing the chemical formula from the word formula

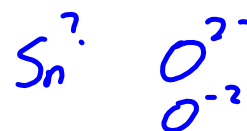
▪ This is easier because we know the charge on the multivalent metal, just follow the rules for predicting formula.

Example 1: Write the formula for nickel(II) sulfide



	Name		Formula
a) iron and sulfur	iron(III) sulfide		$\text{Fe}_2\text{S}_3(\text{s})$
b) copper and oxygen	copper (II) oxide	$\text{Cu}^{2+} \text{O}^{2-}$	CuO
c) manganese and fluorine	manganese (II) fluoride	$\text{Mn}^{2+} \text{F}^{-1}$	MnF_2
d) gold and nitrogen	gold (III) nitride	$\text{Au}^{3+} \text{N}^{3-}$	AuN
e) chromium and chlorine	chromium (III) chloride		CrCl_3
f) platinum and phosphorus	platinum (IV) phosphide	$\text{P}^{4+} \text{P}^{3-}$	Pt_3P_4
g) nickel and oxygen	nickel (II) oxide		NiO
h) cobalt and bromine	cobalt (II) bromide		CoBr_2
i) tungsten and iodine	tungsten iodide		WI_6
j) manganese and sulfur	manganese (II) sulfide		MnS

a) FeCl ₂ (s)	iron(II) chloride
b) FeBr ₃ (s)	iron (III) bromide
c) CrS(s)	chromium (II) sulfide
d) SnO ₂ (s)	tin (IV) oxide
e) Pb ₃ N ₂ (s)	lead (II) nitride
f) HgI ₂ (s)	mercury (II) iodide
g) CrO ₃ (s)	chromium (VI) oxide
h) MnF ₄ (s)	manganese (IV) fluoride
i) Cu ₂ O(s)	copper (I) oxide
j) AuI ₃ (s)	gold (III) iodide





Compounds formed with Polyatomic Ions

- A **polyatomic** ion is an ion made of many non-metal atoms joined together.
- These cluster of atoms carry a net electrical charge (usually negative) and act as either cations or anions when forming an ionic compound (usually act as an anion).
- In chemical reactions, the polyatomic ion stays together and has a charge (that is given in the table of Polyatomic ions)
- There are many polyatomic ions (also called complex ions). See the chart on eth back of your periodic tables. You need to become familiar with these.

Naming Ionic Compounds containing Polyatomic Ions

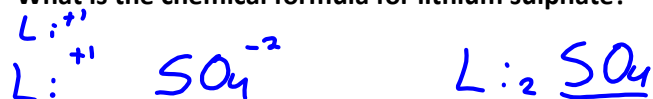
- Metal **cation** or polyatomic **cation** keeps its name
- Polyatomic **anion** keeps its name as it appears on the chart

Predicting Chemical Formulas made with Polyatomic Ions

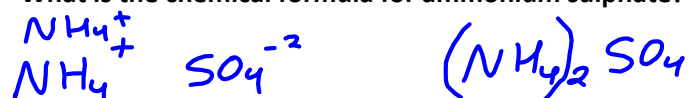
Example 1: What is the chemical formula for sodium hydroxide



Example 2: What is the chemical formula for lithium sulphate?



Example 3: What is the chemical formula for ammonium sulphate?



Example 4: What is the name of $\text{Ca}(\text{OH})_2$?

calcium hydroxide

Example 5: What is the name of $\text{K}_2\text{Cr}_2\text{O}_7$?

K^+ $\text{Cr}_2\text{O}_7^{2-}$
potassium dichromate

Important to Note:

- Brackets are important and necessary if there is more than one polyatomic ion
- Don't change the names of polyatomic ions when naming

COMBINE	IONS (optional)	FORMULA	NAME
iron(II) & nitrate	Fe^{2+} NO_3^-	$\text{Fe}(\text{NO}_3)_2$	iron(II) nitrate
aluminium & nitrate	Al^{3+} NO_3^-	$\text{Al}(\text{NO}_3)_3$	aluminium nitrate
sodium & sulfate		Na_2SO_4	sodium sulfate
lead(IV) & sulfate		$\text{Pb}(\text{SO}_4)_2$	lead (IV) sulfate
magnesium & carbonate		MgCO_3	magnesium carbonate
gold(III) & sulfite		$\text{Au}_2(\text{SO}_3)_3$	gold (III) sulfite
zinc & hydrogencarbonate		$\text{Zn}(\text{HCO}_3)_2$	zinc hydrogen carbonate
ammonium & nitrate		NH_4NO_3	ammonium nitrate
copper(I) & phosphate		Cu_3PO_4	copper (I) phosphate
silver & hydroxide		AgOH	silver hydroxide
aluminium & hydroxide	Al^{3+} OH^-	$\text{Al}(\text{OH})_3$	aluminium hydroxide
lead(II) & phosphate		$\text{Pb}_3(\text{PO}_4)_2$	lead (II) phosphate
potassium & acetate		$\text{K}(\text{CH}_3\text{COO})$	potassium acetate
manganese(V) & sulfate		$\text{Mn}_2(\text{SO}_4)_5$	manganese (V) sulfate

1) calcium acetate	$\text{Ca}(\text{H}_3\text{COO})_2$
2) potassium chloride	KCl
3) ammonium carbonate	$(\text{NH}_4)_2\text{CO}_3$
4) sodium nitride	Na_3N
5) titanium(IV) hypochlorite	$\text{Ti}(\text{OCl})_4$
6) iron(III) sulfide	Fe_2S_3
7) zinc dichromate	ZnCr_2O_7
8) platinum(IV) oxide	PtO_2
9) aluminium hydroxide	$\text{Al}(\text{OH})_3$
10) mercury(II) nitrate	$\text{Hg}(\text{NO}_3)_2$
11) strontium fluoride	SrF_2
12) tin(IV) hydrogenoxalate	$\text{Sn}(\text{HOOC})_4$
13) calcium peroxide	CaO_2
14) gold(I) sulfate	Au_2SO_4
15) lead(IV) thiocyanate	$\text{Pb}(\text{SCN})_4$
16) nickel(III) sulfide	Ni_2S_3

17) $\text{CsI}(\text{s})$		
18) $\text{SnCl}_4(\text{s})$		
19) $\text{Cr}(\text{NO}_3)_3(\text{s})$		
20) $(\text{NH}_4)_3\text{PO}_4(\text{s})$		
21) $\text{Cu}_2\text{SO}_4(\text{s})$		
22) $\text{Mg}(\text{H}_2\text{PO}_4)_2(\text{s})$		
23) $\text{Na}_2\text{S}_2\text{O}_3(\text{s})$		
24) $\text{AgClO}_3(\text{s})$		
25) $\text{Zn}(\text{OH})_2(\text{s})$		