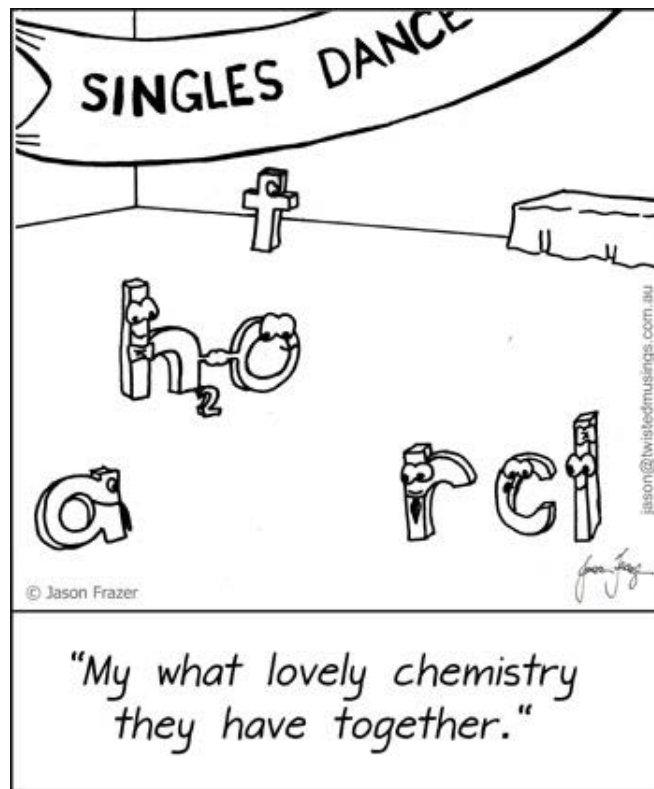


science 10

unit 1: chemistry



book 3: names & formulas of compounds

name: key

block: _____

PART A: NAMING & FORMULA OF IONIC COMPOUNDS WITH MONOTOMIC IONS

The Chemical Name of an Ionic Compound

Ionic compounds are compounds that are composed of positive ions and negative ions.

A chemical formula indicates the elements present in the ionic compound.

The chemical name of an ionic compound always has 2 parts:

- metal (+)
- non-metal (-)

eg. calcium chloride
 CaCl_2
 subscript

In the formula of an ionic compound, the subscript indicate the ratio in which the positive ions and negative ions are present together in the compound.

The ratio of atoms in an ionic compound determines what that compound looks like. Ionic compounds form a highly organized crystalline lattice structure.

FOR EXAMPLE:

The ions in the sodium chloride crystal line up this way because of the forces acting between the ions.

The oppositely charged ions are attracted to each other, and the similarly charged ions repulse each other.

The combination of charges forms the arrangement of ions shown in Figure 4.19.

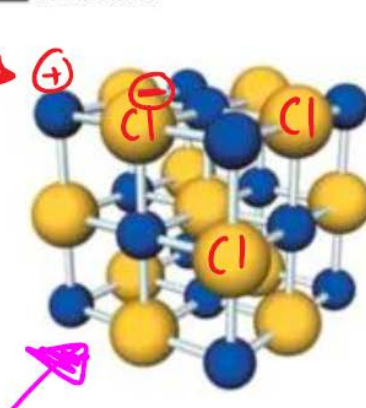


Figure 4.19 The arrangement of ions in sodium chloride



REMEMBER:

Elements that form positive ions are called cations and those that form negative ions are called anions. The table below lists the name and formula of some cations and anions.

Cations and anions are attracted to each other forming an ionic bond.

Remember that a compound has a total charge of ZERO.

"electrostatic attraction"
 = strong bond

Positive ions (cations)		Negative ions (anions)	
Ion name	Formula	Ion name	Formula
Magnesium	Mg^{2+}	Chloride	Cl^-
Sodium	Na^+	Carbonate	CO_3^{2-}
Ammonium	NH_4^+	Hydroxide	OH^-
Aluminium	Al^{3+}	Oxide	O^{2-}
Calcium	Ca^{2+}	Nitride	N^{3-}
Lithium	Li^+	Nitrate	NO_3^-
Copper(II)	Cu^{2+}	Sulfate	SO_4^{2-}
Chromium(III)	Cr^{3+}	Bromide	Br^-

1. FROM CHEMICAL FORMULA --> COMPOUND NAME



Ions of Non-metals

Example: Name the compound formed:

Chemical formula



Step 1: identify
metal - sodium
non-metal - chlorine

Step 2: combine

Sodium chloride

The first part of names the positive ion, sodium metal

The positive ion is always a metal in a compound containing two elements.

The positive, metal ion is **always written first.**

Element	Ion	Symbol
fluorine	fluoride	F ⁻
chlorine	chloride	Cl ⁻
bromine	bromide	Br ⁻
iodine	iodide	I ⁻
oxygen	oxide	O ²⁻
sulfur	sulfide	S ²⁻
selenium	selenide	Se ²⁻
nitrogen	nitride	N ³⁻
phosphorus	phosphide	P ³⁻

The second part is the negative ion, chloride an ion of chlorine.

The negative ion is always a non-metal in a compound containing two elements.

The non-metals name always ends with "ide"

The negative, non-metal ion is **always written second.**

Example: Name the compound:



Calcium Oxygen

= Calcium oxide

PRACTICE

Name the following:

- ZnI₂
- Na₃N
- MgS
- BaCl₂
- Ba₃P₂

zinc iodide
sodium nitride
magnesium sulfide
Barium chloride
Barium phosphide

carbon
oxygen
nitrogen
sulphur
iodine
bromine
chlorine
fluorine

"ide"



ASSIGNMENT #1: Ionic Compounds Naming

This assignment is to be completed below in the space provided.

Name the following ionic compounds.

1. Potassium + iodine

Potassium iodide

2. Sodium + oxygen

Sodium oxide

3. Potassium + bromine

Potassium bromide

4. Zinc + sulfur

Zinc sulfide

5. Silver + oxygen

Silver oxide

6. Aluminum + iodine

Aluminium iodide

7. Lithium + bromine

Lithium bromide

8. Potassium + sulfur

Potassium sulfide

9. BaF_2

Barium fluoride

10. Al_2O_3

Aluminium oxide

11. NaF

Sodium fluoride

12. MgF_2

Magnesium fluoride

13. BeS

Beryllium sulfide

14. K_2O

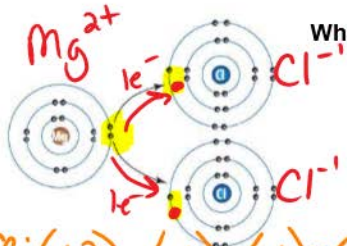
Potassium oxide

15. MgI_2

Magnesium iodide

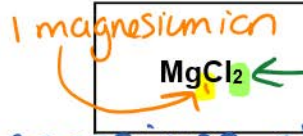
2" FROM 0cadci bX'bUaY-->0\Ya]WU` Zcf ai ` U

Formula Writing - Ionic Compounds



What is a chemical formula?

Tells us what atoms make up the compound, and how many of each.



Balance: $(+2) + (-1) + (-1) = 0$
 Charge Balancing Method of Formula Writing

Charge Balancing/ "Swap & Drop" Method of Formula Writing

EXAMPLE:

Aluminum chloride

Step 1: Look up ion symbols + charges



atom ratio: 1 Al : 3 Cl
 Al^{3+} Cl^{-1}
 $(+3) + (-1) + (-1) + (-1) = 0$

Chemical Formula
 Al_1Cl_3
 ⇒ $AlCl_3$

don't have to write 1

Step 2: Balance the charges

MUST = 0

PRACTICE

Sodium sulfide

Step 1: ion symbols + charges



atom ratio: 2 Na : 1 S
 Na^{+} S^{2-}
 $(+1) + (+1) + (-2) = 0$

chemical formula
 Na_2S
 ⇒ Na_2S

Step 2: Balance charges

PRACTICE

Ca^{+2} N^{-3}
 $3:2$
 Ca_3N_2

	N ⁻³	O ⁻²	P ⁻³	Br ⁻¹
Ca ⁺² Ca and N	Ca ₃ N ₂	CaO 2:2 = 1:1	Ca ₃ P ₂	CaBr ₂
Rb ⁺¹	Rb ₃ N	Rb ₂ O	Rb ₃ P	RbBr 1:1
Al ⁺³	AlN 3:3 = 1:1	Al ₂ O ₃	AlP 3:3 = 1:1	AlBr ₃
Be ⁺²	Be ₃ N ₂	BeO 2:2 = 1:1	Be ₃ P ₂	BeBr ₂



ASSIGNMENT #2: Ionic Compounds Naming & Formula Review pg 6 + 7 T
his assignment is to be completed below in the space provided.

Combine the following:	Ions are:	Chemical Formula is:	Chemical Name is:	Total number of atoms is:
Calcium + chlorine	Ca^{2+} Cl^-	CaCl_2	calcium chloride	$1 \text{ Ca} + 2 \text{ Cl} = 3$
Hydrogen + iodine	H^+ I^-	HI	hydrogen iodide	$1 \text{ H} + 1 \text{ I} = 2$
Magnesium + sulfur	Mg^{2+} S^{2-}	MgS	magnesium sulfide	$1 \text{ Mg} + 1 \text{ S} = 2$
Aluminum + oxygen	Al^{3+} O^{2-}	Al_2O_3	aluminium oxide	$2 \text{ Al} + 3 \text{ O} = 5$
Lithium + fluorine	Li^+ F^-	LiF	Lithium fluoride	$1 \text{ Li} + 1 \text{ F} = 2$
Sodium + bromine	Na^+ Br^-	NaBr	sodium bromide	$1 \text{ Na} + 1 \text{ Br} = 2$
Barium + nitrogen	Ba^{2+} N^{3-}	Ba_3N_2	Barium nitride	$3 \text{ Ba} + 2 \text{ N} = 5$
Beryllium + chlorine	Be^{2+} Cl^-	BeCl_2	Beryllium chloride	$1 \text{ Be} + 2 \text{ Cl} = 3$
Zinc + oxygen	Zn^{2+} O^{2-}	ZnO	zinc oxide	$1 \text{ Zn} + 1 \text{ O} = 2$
Magnesium + iodine	Mg^{2+} I^-	MgI_2	magnesium iodide	$1 \text{ Mg} + 2 \text{ I} = 3$



ASSIGNMENT #2b: Ionic Compounds Naming

This assignment is to be completed below in the space provided.

OOPS! Duplicate worksheet....same as Assignment #1 (you do not have to do it twice...unless you want to!)

Name the following ionic compounds.

- | | |
|------------------------------------|--------------------|
| 1. Potassium + iodine | Potassium iodide |
| 2. Sodium + oxygen | Sodium oxide |
| 3. Potassium + bromine | Potassium bromide |
| 4. Zinc + sulfur | Zinc sulfide |
| 5. Silver + oxygen | Silver oxide |
| 6. Aluminum + iodine | Aluminium iodide |
| 7. Lithium + bromine | Lithium bromide |
| 8. Potassium + sulfur | Potassium sulfide |
| 9. BaF ₂ | Barium fluoride |
| 10. Al ₂ O ₃ | Aluminium oxide |
| 11. NaF | Sodium fluoride |
| 12. MgF ₂ | Magnesium fluoride |
| 13. BeS | Beryllium sulfide |
| 14. K ₂ O | Potassium oxide |
| 15. MgI ₂ | Magnesium iodide |

PART B: NAMING & FORMULA WITH MULTIVALENT METAL IONS

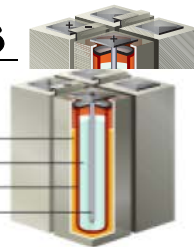


Figure 4.22 A Na-NiCl₂ battery, also called a zebra battery, operates at temperatures above 250°C and can be used to power vehicles.

Compounds Containing a Multivalent Metal

Some metals are multivalent, which means they can form ions more than one way.

Multivalent metals can form two (or more) positive ions with different ion charges.

For example, find nickel (Ni) in the periodic table.

The periodic table lists two ion charges, 2+ and 3+

An example of an ionic compound containing nickel is NiCl₂, used in some kinds of batteries.

Which ion of nickel is contained in NiCl₂? Ni²⁺

To distinguish between two ions formed from multivalent metals, you use the **Roman numerals** from I to VII that correspond to ion charges from 1 to 7

- Ni²⁺ or nickel(II) is called "nickel two" and shows the nickel ion has an ion charge of 2+.
- Ni³⁺ or nickel(III) is called "nickel three" and shows the nickel ion has an ion charge of 3+.

Table 4.7 Roman Numerals

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

Writing Formulas for Ionic Compounds that Contain a Multivalent Metals:

1. FROM COMPOUND NAME --> CHEMICAL FORMULA

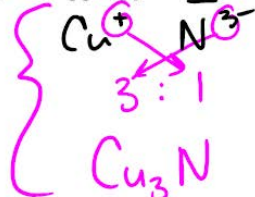
Writing Formulas of Compounds Containing a Multivalent Metal

Steps	Examples	
	manganese(IV) sulfide	cobalt(III) oxide
1. Identify each ion and its charge.	Mn ⁴⁺ S ²⁻	Co ³⁺ O ²⁻
2. Determine the total charges needed to balance positive with negative.	2 : 4 (simplify)	2 : 3
3. Note the ratio of positive ions to negative ions.	Mn = 1 : 2 = S	Co = 2 : 3 = O
4. Use subscripts to write the formula. A "1" is not shown in the subscripts.	MnS ₂	Co ₂ O ₃

PRACTICE

(a) copper(I) nitride

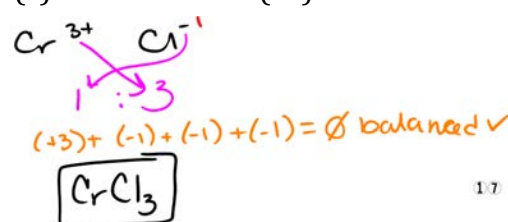
N: -3 = -3
Cu: +1, +1, +1 = +3
Total 0



(b) iron(II) phosphide



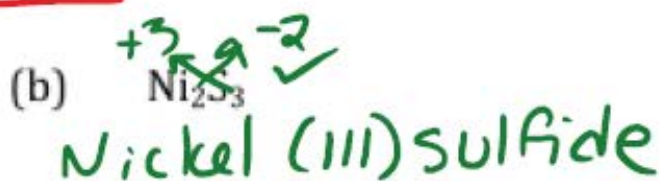
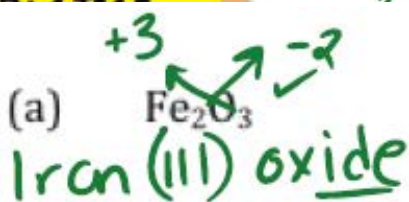
(c) chromium (III) chloride



2. FROM CHEMICAL FORMULA --> COMPOUND NAME "REVERSE SWAP + DROP"

Naming Ionic Compounds Containing a Multivalent Metal

Steps	Examples	
	A) Au_3N	PdS_2
1. Identify the metal.	$Au = \text{gold}$	
2. Verify that it can form more than one kind of ion by checking the periodic table.	Au^{3+} or Au^+	Pd^{2+} or Pd^{4+}
3. Determine the ratio of the ions in the formula.	Reverse Swap+drop Au_3N_1	B) Pd^{+2} S^{-1} $Pd = \text{palladium}$
4. Note the charge of the negative ion from the periodic table.	we know = N^{3-}	S^{2-}
5. The positive and negative charges must balance out. Determine what the charge needs to be on the metal ion to balance the negative ion.	$Au: +1, +1, +1 = +3$ $N: -3 = -3$ $Au^+ \quad N^{3-}$	we must DOUBLE the charges, because they are simplified from before know S^{2-} Pd^{4+} and S^{2-}
6. Write the name of the compound.	Gold (I) nitride	Palladium (IV) sulfide



Each of these compounds contains a multivalent metal ion. That means that the name of the metal ion will contain a Roman numeral, which you will need to determine. Write the names of the following compounds.



- (b) FeI_2 A) Lead (IV) fluoride
 B) Iron (II) iodide
 C) Mercury (II) iodide
 (c) HgI_2 D) Mercury (II) nitride
 E) Iron (III) oxide

- (g) MnS f) Tin (IV) phosphide
 g) Manganese (II) sulfide
 h) Manganese (IV) sulfide
 (h) MnS_2 i) Vanadium (V) chloride
 j) Nickel (III) sulfide



Homework

Assignment #3: Practice Problems #1 and #2

Complete this assignment in the space provided below

Practice Problems

1. Write the formulas of the following compounds containing multivalent metals.

(a) manganese(II) oxide



(h) tin(II) sulfide



(b) manganese(IV) oxide



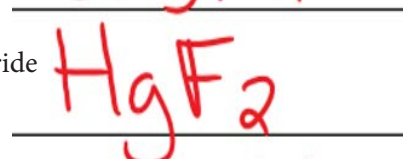
(i) tin(II) nitride



(c) chromium(II) bromide



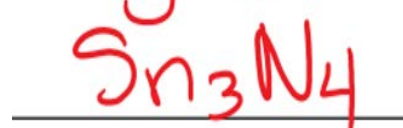
(j) mercury(II) fluoride



(d) chromium(III) bromide



(k) tin(IV) nitride



(e) lead(IV) chloride



(l) copper(I) iodide



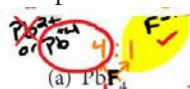
(f) iron(III) phosphide



(m) copper(II) iodide



2. Each of these compounds contains a multivalent metal ion. That means that the name of the metal ion will contain a Roman numeral, which you will need to determine. Write the names of the following compounds.



(a) PbF₄

lead(IV) fluoride

(b) FeI₂

iron(II) iodide

(c) HgI₂

mercury(II) iodide

(d) Hg₃N₂

mercury(III) nitride

~~Fe²⁺~~
~~Fe³⁺~~ Fe³⁺ O²⁻

iron(III) oxide

(f) Sn₃P₄

tin(IV) phosphide
Mn²⁺ Mn³⁺ Mn⁴⁺ S²⁻
check non-metal first.

(g) MnS

manganese(II) sulfide ⇒ Mn²⁺ S²⁻

(h) MnS₂

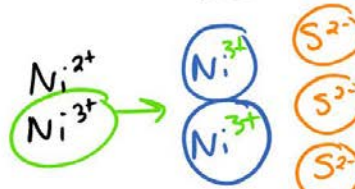
manganese(IV) sulphide Mn²⁺ S²⁻
(+2) + (-2) = 0

(i) VCl₅

vanadium(V) chloride

(j) Ni₂S₃

nickel(III) sulphide



PART C: NAMING & FORMULA WITH MULTIVALENT METAL IONS

REMEMBER THAT:

A polyatomic ion is composed of more than one type of atom joined by covalent bonds.






















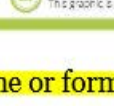
Because polyatomic ions carry an electric charge, they cannot exist on their own.

An example of a polyatomic ion is: part of an ionic compound.

carbonate, CO_3^{2-}

The figure right (and your data booklet) lists some common polyatomic ions.

You do not have to memorize the names.

POLYATOMIC IONS: NAMES, FORMULAE & CHARGES						
A polyatomic ion is a charged species consisting of two or more atoms covalently bonded together. Here's a guide to some of the most common examples:						
 AMMONIUM Formula: NH_4^+	 ACETATE Formula: $\text{C}_2\text{H}_3\text{O}_2^-$	 CARBONATE Formula: CO_3^{2-}	 CHLORATE Formula: ClO_3^-	 CHLORITE Formula: ClO_2^-	 CHROMATE Formula: CrO_4^{2-}	 CYANIDE Formula: CN^-
 DICHROMATE Formula: $\text{Cr}_2\text{O}_7^{2-}$	 HYDROXIDE Formula: OH^-	 HYDROGEN CARBONATE Formula: HCO_3^-	 HYDROGEN SULFATE Formula: HSO_4^-	 HYDROXIDE Formula: OH^-	 HYPOCHLORITE Formula: ClO^-	 NITRATE Formula: NO_3^-
 NITRITE Formula: NO_2^-	 PERCHLORATE Formula: ClO_4^-	 PERMANGANATE Formula: MnO_4^-	 PEROXIDE Formula: O_2^{2-}	 PHOSPHATE Formula: PO_4^{3-}	 SULFATE Formula: SO_4^{2-}	 SULFITE Formula: SO_3^{2-}
 THIOSULFATE Formula: $\text{S}_2\text{O}_3^{2-}$						



Write the name or formula of the following polyatomic ions:

1. NH_4^+

ammonium ion

2. CrO_4^{2-}

chromate ion

3. Acetate

CH_3COO^-

4. CN^-

cyanide ion

5. SO_4^{2-}

sulphate

6. Sulfite

SO_3^{2-}

7. Hypochlorite

ClO^-

8. OH^-

hydroxide ion

9. Bisulphite

HSO_3^-

10. HCO_3^-

hydrogen carbonate (or bicarbonate)

* when we name with polyatomics we NEVER change name in any way.

- Polyatomic ions are treated just like other ion but when naming compounds we DO NOT change their endings (they are already ions)

○ Example: NO_3^- is nitrate, not nitraide ~~no "ide" ending!~~

- You will recognize that there is a polyatomic ion present, because the compound will look like it has more than TWO parts. It doesn't! Just split up the compound after the metal, and then find the other ion in your data booklet. most polyatomics have all non-metals.
- Remember to use BRACKETS in the formula if more than one is present, as you will see from examples.

1. FROM CHEMICAL FORMULA --> COMPOUND NAME



Step 1: How do you know you are dealing with a polyatomic ion?

There are more than 2 elements

Step 2:

identify metal: Ca^{2+} = calcium ~~ion~~

don't change ending of polyatomic ion

Step 3:

identify non-metal part: CO_3^{2-} = carbonate ~~ion~~

name: Calcium carbonate



Step 1:

3 elements are involved: N, H, Cl => has polyatomic ions.

Step 2:

NH_4^+ is a metal polyatomic ion⁺ = Ammonium

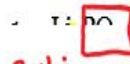
Step 3:

Cl^- is a non-metal ion = chloride

Name: ammonium chloride

PRACTICE

Write the name of the following compounds that contain polyatomic ions.



Example: Write the name of the following compounds.

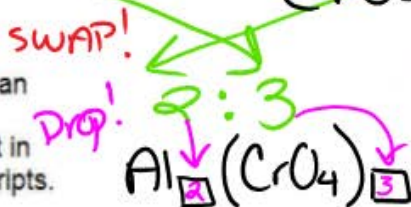
1. Li_3PO_4	Li^{+1}	PO_4^{-3}	Li_3PO_4 lithium phosphate
2. $(\text{NH}_4)_3\text{P}$	NH_4^{+1}	P^{-3}	$(\text{NH}_4)_3\text{P}$ ammonium phosphide
3. $\text{Ca}(\text{OH})_2$	Ca^{+2}	OH^{-1}	$\text{Ca}(\text{OH})_2$ calcium hydroxide
4. $\text{Fe}(\text{OH})_3$	Fe^{+3}	OH^{-1}	$\text{Fe}(\text{OH})_3$ iron (III) hydroxide.
5. $\text{Mn}(\text{SO}_4)_2$	Mn^{+4}	SO_4^{-2}	$\text{Mn}(\text{SO}_4)_2$ manganese (IV) sulphate.

2. FROM COMPOUND NAME --> CHEMICAL FORMULA

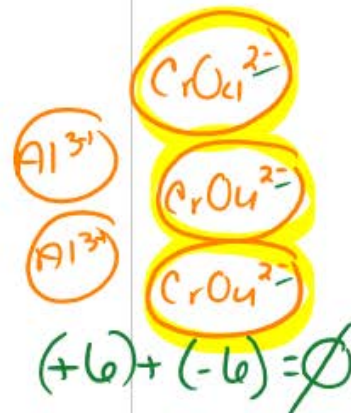
Aluminum chromate



Note that if there is more than one of the polyatomic compounds, you must put it in parenthesis and add subscripts.



Cross the charges circled to balance and neutralize the compound.



Notice the use of brackets in the formula to allow the ratio of ions to be shown correctly.

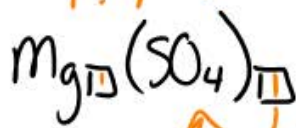
Brackets are dropped if the ion is **not polyatomic** or if the **ratio** number outside the brackets is 1.

When you read the formula, you should always remember that the ratio numbers and brackets are implied.

FOR EXAMPLE: Na_2CO_3 as sodium carbonate with 2 Na^+ ions for every 1 CO_3^{2-} ion.

$\text{Ca}(\text{OH})_2$ as calcium hydroxide with 1 Ca^{2+} ions for every 2 OH^- ion.

Magnesium sulfate



drop brackets



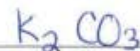
PRACTICE

1. Write the formula of each of the following compounds:

a. barium nitrate



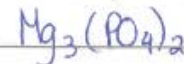
b. potassium carbonate



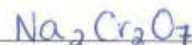
c. nickel (II) sulfate



d. magnesium phosphate



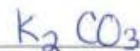
e. sodium dichromate



a. barium nitrate



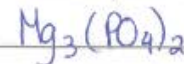
b. potassium carbonate



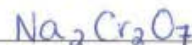
c. nickel (II) sulfate



d. magnesium phosphate



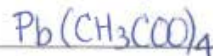
e. sodium dichromate



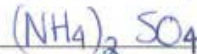
f. iron (II) chromate



g. lead (IV) acetate



h. ammonium sulfate



Homework

Assignment #4 POLYATOMIC ION SWAP 'N' DROP!

Complete this assignment in the space provided

Part 1 – Write the name for each of the following ionic compounds.

1. Na_2CO_3 sodium carbonate

2. $\text{Fe}(\text{OH})_3$

iron (III) hydroxide

3. KCH_3COO

potassium acetate

4. $\text{Co}(\text{ClO})_2$

cobalt (II) chlorite

5. $(\text{NH}_4)_3\text{PO}_4$

ammonium phosphate

6. $\text{Mg}_3(\text{PO}_4)_2$

magnesium phosphate

7. $\text{Ca}(\text{CH}_3\text{COO})_2$

calcium acetate

8. $\text{Mg}_3(\text{PO}_3)_2$

9. $(\text{NH}_4)_3\text{P}$

ammonium phosphide

10. $\text{Ni}(\text{HS})_3$

nickel (III) bisulphide

11. $(\text{NH}_4)_3\text{PO}_4$

12. CuCN

copper(I) cyanide

13. $\text{Al}(\text{OH})_3$

aluminium hydroxide

14. $\text{Mn}(\text{SO}_3)_2$

manganese(II) sulphite.

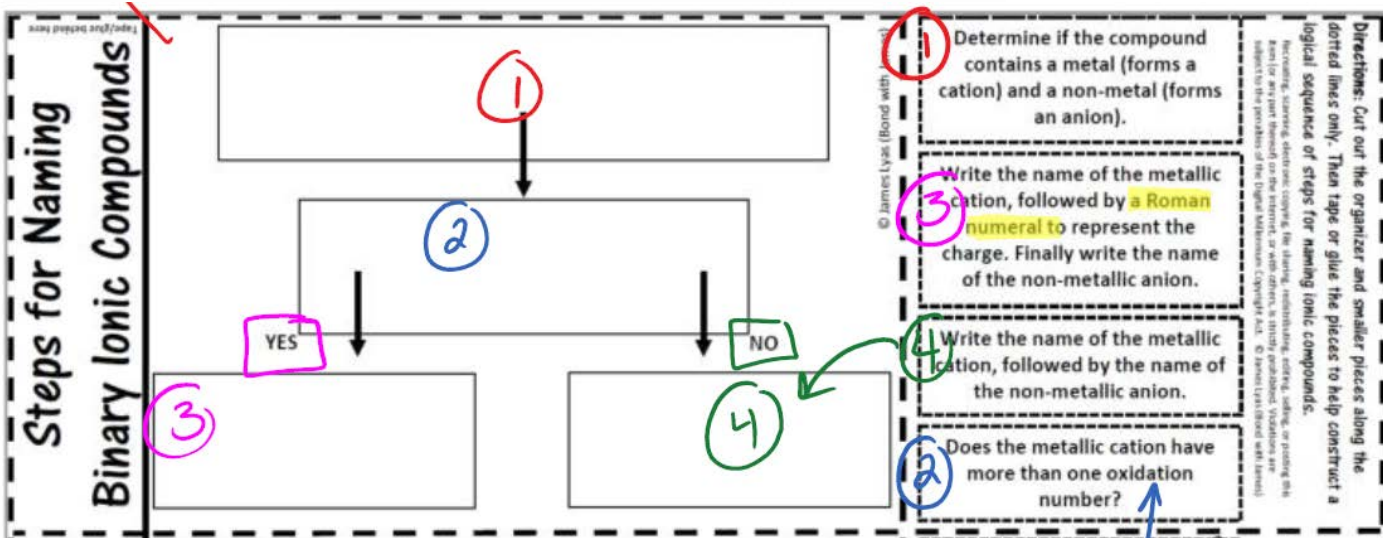
Part 2 – Complete the formula by writing the ratio for each of the following ionic compounds:

	NO_3^- ⁻¹	SO_4^{2-} ⁻²	PO_4^{3-} ⁻³	ClO^- ⁻
$+2$ Ca	$\text{Ca}(\text{NO}_3)_2$	$\text{Ca}_3(\text{SO}_4)_2$	$\text{Ca}_3(\text{PO}_4)_2$	$\text{Ca}(\text{ClO})_2$
$+1$ Rb	RbNO_3	Rb_3SO_4	Rb_3PO_4	RbClO
$+3$ Al	$\text{Al}(\text{NO}_3)_3$	Al_2SO_4	AlPO_4	$\text{Al}(\text{ClO})_3$
$+1$ NH_4^+	NH_4NO_3	$(\text{NH}_4)_3\text{SO}_4$	$(\text{NH}_4)_3\text{PO}_4$	NH_4ClO

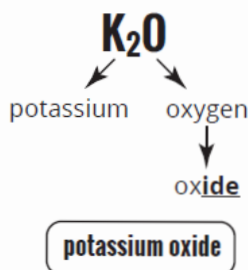
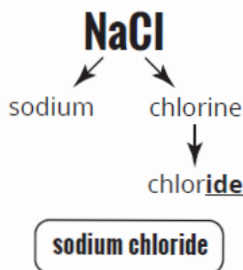
Writing Compound Names

Ionic Bonds

(a bond between a metal and a nonmetal)

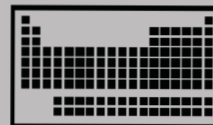


Naming a Binary Ionic Compound (two elements with no transition metals)

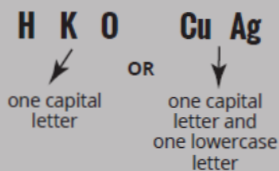


Element or Polyatomic Ion?

Elements are found on the periodic table.



Elements look like this:

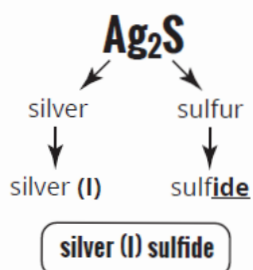
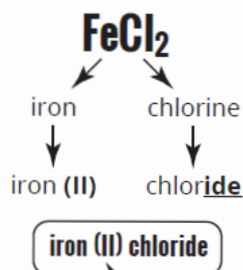


Polyatomic ions are groups of two or more elements.



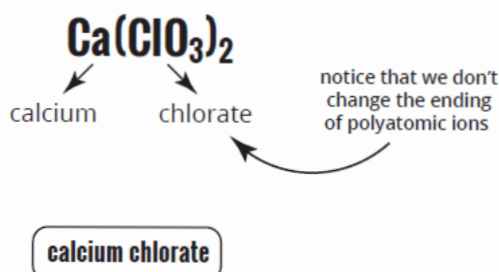
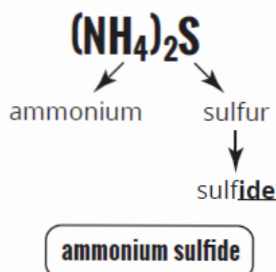
They stick together.

Naming a Compound with a Transition Metal



you can figure out this number based on the number of atoms of the second element

Naming a Compound with a Polyatomic Ion



Homework

Assignment #5: Ionic Compounds MIXED REVIEW

1 Identify the following by naming the ionic compounds.

- a $MgCl_2$ magnesium chloride
- b $(NH_4)_2O$ ammonium oxide
- c Ca_3N_2 calcium nitride
- d $CuCO_3$ copper(II) carbonate
- e $Cr_2(SO_4)_3$ chromium(III) sulfate
- f $Cr(NO_3)_3$ chromium(III) nitrate
- g $Al(OH)_3$ aluminum hydroxide

2 Propose formulas for the following ionic compounds.

- a lithium carbonate $LiCO_3$
- b aluminium bromide $AlBr_3$
- c copper(II) nitrate Cu_3N_2
- d sodium chloride $NaCl$
- e calcium bromide $CaBr_2$
- f ammonium hydroxide NH_4OH
- g lithium nitride Li_3N

Questions

3 a Apply the rules above to write the formulas and names for ionic compounds in the tables below.

	Cl^-	F^-	NO_3^-	O^{2-}	CO_3^{2-}	PO_4^{3-}
Na^+	<u>$NaCl$</u>	<u>NaF</u>	<u>$NaNO_3$</u>	<u>Na_2O</u>	<u>Na_2CO_3</u>	<u>Na_3PO_4</u>
H^+	<u>HCl</u>	<u>HF</u>	<u>HNO_3</u>	<u>H_2O</u>	<u>H_2CO_3</u>	<u>H_3PO_4</u>
Li^+	<u>$LiCl$</u>	<u>LiF</u>	<u>$LiNO_3$</u>	<u>Li_2O</u>	<u>Li_2CO_3</u>	<u>Li_3PO_4</u>
NH_4^+	<u>NH_4Cl</u>	<u>NH_4F</u>	<u>NH_4NO_3</u>	<u>$(NH_4)_2O$</u>	<u>$(NH_4)_2CO_3$</u>	<u>$(NH_4)_3PO_4$</u>
Mg^{2+}	<u>$MgCl_2$</u>	<u>MgF_2</u>	<u>$Mg(NO_3)_2$</u>	<u>MgO</u>	<u>$MgCO_3$</u>	<u>$Mg_3(PO_4)_2$</u>
Ca^{2+}	<u>$CaCl_2$</u>	<u>CaF_2</u>	<u>$CaNO_3$</u>	<u>CaO</u>	<u>$CaCO_3$</u>	<u>$Ca_3(PO_4)_2$</u>
Al^{3+}	<u>$AlCl_3$</u>	<u>AlF_3</u>	<u>$Al(NO_3)_3$</u>	<u>Al_2O_3</u>	<u>$Al_2(O_3)_3$</u>	<u>$AlPO_4$</u>

b

Formula	Name
$CaBr_2$	<u>calcium bromide</u>
HCl	<u>hydrogen chloride</u>
$AlCl_3$	<u>aluminum(III) chloride</u>
Na_3PO_4	<u>sodium phosphate</u>
CaO	<u>calcium oxide</u>
$(NH_4)_2CO_3$	<u>ammonium carbonate</u>

c

Formula	Name
$FeCl_2$	<u>iron(II) chloride</u>
HNO_3	<u>hydrogen nitrate</u>
Ag_2SO_4	<u>silver sulfate</u>
$NaHCO_3$	<u>sodium bicarbonate</u>
CuS	<u>copper(II) sulfate</u>
$Fe(OH)_3$	<u>iron(III) hydroxide</u>

2+ or more atoms

PART D: NAMING & FORMULA OF BINARY COVALENT COMPOUNDS

A binary covalent compound contains 2 or more elements joined together by one or more covalent bonds.

Unlike ionic compounds, they combine chemically by sharing electrons in a covalent bond.

In a covalent compound, the exact precise number of atoms of each element in the molecule is shown by the chemical formula + the name.

For example, H_2O_2 is a covalent compound that may be familiar to you as a disinfectant. (hydrogen peroxide)

Its name is di-hydrogen dioxide.

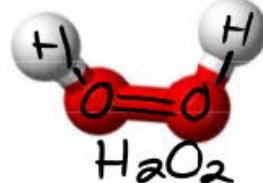
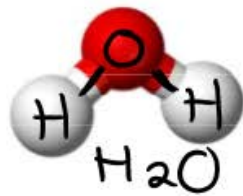
Each molecule of hydrogen peroxide has 2 hydrogen atoms and 2 oxygen atoms, for a total of four atoms in each molecule.

DO NOT SIMPLIFY covalent compounds.

Notice that the formula is not reduced to HO, as would be the case for an ionic compound where the formula is simplified into the lowest ratio.

In a covalent compound, the formula + name show the actual number of atoms of each element in the molecule.

A) $\text{O} = \text{Oxygen}$
 $\text{H} = \text{Hydrogen}$

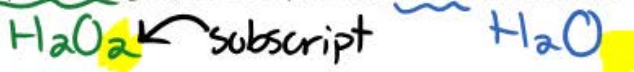


structure = properties

In chemistry, we must have a set of naming rules to distinguish compounds and make sure the same language is spoken. Different compounds have different formulas, names, and chemical properties.

So in formula of covalent compounds, the subscripts are VERY IMPORTANT!

Consider that hydrogen peroxide again, and compare it to water. What are the chemical formula of each:



They differ in 1 oxygen, yet their chemical characteristics are vastly different.

Water is vital to our survival and hydrogen peroxide is poisonous if consumed.

Naming Covalent Compounds

Prefixes "are words that go in front", indicate the number of atoms of each element that appear in the formula:

Prefix	mono	di	tri	tetra	penta	hexa	hepta	octa	nona	deca
Subscript (number)	1	2	3	4	5	6	7	8	9	10

Names and Formulas of Binary Molecular Compounds

(Covalent Compounds)

Table 4.13 Prefixes Used in Naming Binary Covalent Compounds

Prefix	Number
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

Any cation and anion combine in a single ratio that is easily predictable from their charges. This is why ionic compounds' names do not need to explicitly contain their formulas.

On the other hand, two non-metal atoms may share electrons and combine in several ratios. Therefore, the name of the molecular compound must reveal its formula to distinguish it from the other compounds of the same two elements. The name of a molecular compound uses a "Prefix Code" to provide its formula.

The prefixes used are shown LEFT.

The names of all binary compounds have an "-ide" suffix.

N_2O_4 is therefore Dinitrogen tetraoxide.

Note that the number of atoms comes before the name of the element but after the symbol of the element. = N_2 not $2N$

The prefix mono- is understood for the first element named if no prefix is stated.

For example, carbon dioxide is CO_2 , NOT monocarbon dioxide
 1 carbon implied

Sample Problem — Determining the FORMULA of a Molecular Compound from Its Name

What is the formula of xenon tetrafluoride?

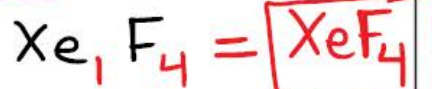
no prefix = 1 \rightarrow tetra = 4

xenon = Xe fluoride = F

What to Think about

- Write the symbols of each element and the number of atoms of each.
- Rewrite this information as a formula.

How to Do It



Sample Problem — Determining the NAME of a Molecular Compound from Its Formula

What is the name of P_4S_{10} ?

P = phosphorus S = sulfur

What to Think about

- Write the names of each element and the number of atoms of each.
- Rewrite this information using the prefix code.

How to Do It

$P_4 =$ tetra

$S_{10} =$ deca

$P_4S_{10} =$ Tetraphosphorus decasulfur

$=$ Tetraphosphorus decasulfide

PRACTICE

Determining the Names and Formulas of Molecular Compounds

- Write the formula of each of the following molecular compounds:

(a) nitrogen monoxide



(c) dinitrogen teroxide



(b) nitrogen dioxide



(d) dinitrogen trioxide



- Name each of the following molecular compounds:

(a) PCl_5

Phosphorus pentachloride

(c) CO

carbon monoxide

(b) SO_2

sulfur dioxide

(d) P_2O_5

diphosphorus pentoxide

Practice Problems

1. Write the names of the following compounds.

- | | |
|--------------------------------------|--|
| (a) N_2O dinitrogen monoxide | (f) N_2O_4 dinitrogen tetraoxide |
| (b) CO_2 carbon dioxide | (g) P_4S_{10} tetraphosphorus decaulfide |
| (c) PI_3 phosphorus triiodide | (h) S_2F_{10} disulfur decafluoride |
| (d) PCl_5 phosphorus pentachloride | (i) NI_3 nitrogen triiodide |
| (e) SO_2 sulfur dioxide | (j) NO nitrogen monoxide |

2. Write the formulas of the following compounds.

- | | |
|--------------------------------------|-------------------------------------|
| (a) nitrogen tribromide NBr_3 | (f) sulfur trioxide SO_3 |
| (b) sulfur hexafluoride SF_6 | (g) phosphorus pentabromide PBr_5 |
| (c) dinitrogen tetrasulfide N_2S_4 | (h) diiodine hexachloride I_2Cl_6 |
| (d) oxygen difluoride OF_2 | (i) dichlorine monoxide Cl_2O |
| (e) carbon tetraiodide CI_4 | (j) xenon hexafluoride XeF_6 |

3. Identify each of the following compounds as either ionic or covalent.

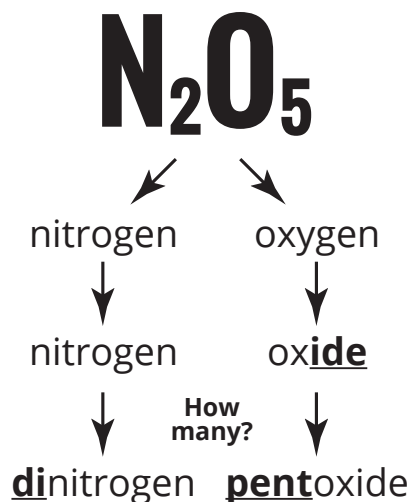
- | | |
|--|---|
| (a) $(NH_4)_2S$ ionic | (e) N_2O_3 covalent (dinitrogen trioxide) |
| (b) OCl_2 covalent (oxygen dichloride) | (f) SCl_2 covalent (sulfur dichloride) |
| (c) $SnCl_2$ ionic | (g) NBr_3 covalent (nitrogen tribromide) |
| (d) $NaNO_3$ ionic | (h) FeF_2 ionic |

metals!

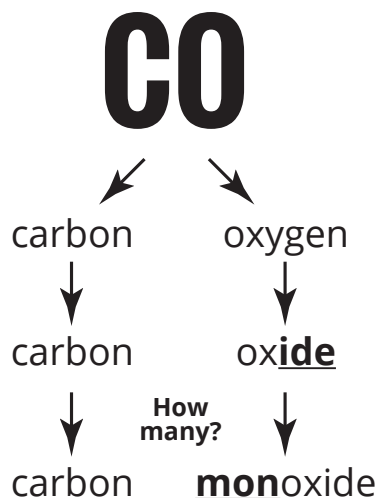
Writing Compound Names

Covalent Bonds

(a bond between two nonmetals)



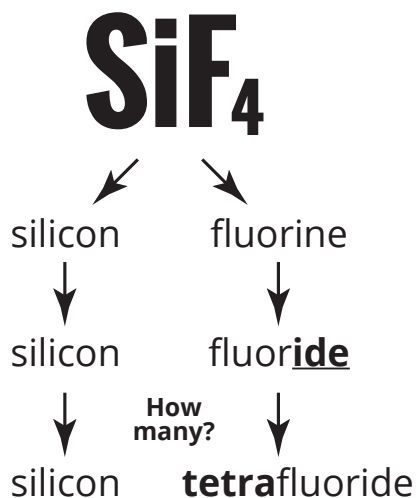
dinitrogen pentoxide



carbon monoxide

prefix	number
<i>mono-</i>	1
<i>di-</i>	2
<i>tri-</i>	3
<i>tetra-</i>	4
<i>penta-</i>	5
<i>hexa-</i>	6
<i>septa-</i>	7
<i>octa-</i>	8
<i>nona-</i>	9
<i>deca-</i>	10

Notice that we don't use the prefix *mono-* here. That's because it's the first element in the compound.



silicon tetrafluoride

If the element starts with a vowel, you may need to drop the *o-* or *a-* at the end of your prefix.

penta- → **pentoxide**
di- → **dioxide**
tetra- → **tetroxide**
hexa- → **hexoxide**

Homework

Assignment #7: Naming & Formulae Writing MIXED REVIEW
pg 21-23 complete this assignment in the space provided

Chemical names and formulas of ionic compounds

1. Write the name for each of the following compounds.

* Roman numerals for multivalent ions only *

(a) BeS beryllium sulfide

(k) Ni(OH)₂ nickel (II) hydroxide

(b) Hg₃N₂ mercury (II) nitride

(l) K₂Cr₂O₇ potassium dichromate

(c) Cu(NO₃)₂ copper (II) nitrate

(m) ScF₃ scandium fluoride

(d) Ag₂O silver oxide

(n) NaI sodium iodide

(e) CoBr₂ Cobalt (II) bromide

(o) Pb(CO₃)₂ Lead (IV) carbonate

(f) Bi₃(PO₄)₅ Bismuth (III) phosphate

(p) RbClO₂ Rubidium chlorite

(g) CaF₂ Calcium fluoride

(q) K₃P Potassium phosphate

(h) Mn₂O₃ manganese (III) oxide

(r) Mg(CN)₂ Magnesium cyanide

(i) Cr₂(SO₄)₃ Chromium(III) sulfate

(s) SnS Tin sulfide

(j) ZnCl₂ Zinc chloride

(t) NaHCO₃ sodium hydrogen carbonate (also sodium bicarbonate)

2. Write the chemical formula for each of the following compounds.

*remember to balance ion charges! Final compound is neutral.

(a) aluminum bromide AlBr₃

(k) cadmium(II) hydroxide Cd(OH)₂

(b) platinum(II) sulphide PtS₂

(l) zinc phosphate Zn₃(PO₄)₂

(c) strontium sulfite SrSO₃

(m) barium chloride BaCl₂

(d) scandium oxide Sc₂O₃

(n) tin(II) permanganate Sn(MnO₄)₂

(e) titanium(IV) nitrite Ti(NO₂)₄

(o) lithium hypochlorite LiClO

(f) ammonium sulphate (NH₄)₂SO₄

(p) gold(III) sulphate Au₂(SO₄)₃

(g) lithium selenide Li₂Se

(q) sodium nitrate NaNO₃

(h) lead(II) hydrogen sulphate Pb(HSO₄)₂

(r) chromium(III) chloride CrCl₃

(i) sodium acetate NaCH₃COO

(s) potassium carbonate K₂CO₃

(j) cesium chloride CsCl

(t) iron(III) bisulphate Fe(HSO₄)₃

remember to use brackets when there is more than 1 polyatomic ion.

Chemical names and formulas of covalent compounds

1. What is a covalent compound?
a compound made of 2+ NON-metal atoms
2. What type of bond is formed in a covalent compound?
covalent bond => pair of shared e-
3. What is used in naming covalent compounds?
a prefix code
4. Write the chemical formula for each of the following compounds.

(a) silicon dioxide <u>SiO₂</u>	(i) dinitrogen pentoxide <u>N₂O₅</u>
(b) chlorine dioxide <u>ClO₂</u>	(j) dinitrogen monoxide <u>N₂O</u>
(c) tellurium dioxide <u>TeO₂</u>	(k) arsenic tetrabromide <u>AsBr₄</u>
(d) selenium trioxide <u>SeO₃</u>	(l) arsenic pentachloride <u>AsCl₅</u>
(e) carbon disulphide <u>CS₂</u>	(m) disulphide pentoxide <u>S₂O₅</u>
(f) arsenic trichloride <u>AsCl₃</u>	(n) sulphur monochloride <u>SCl</u>
(g) chlorine heptoxide <u>ClO₇</u>	(o) phosphorus trichloride <u>PCl₃</u>
(h) selenium difluoride <u>SeF₂</u>	(p) diphosphorus pentoxide <u>P₂O₅</u>

Checking Concepts

1. List the information about a compound given by the name of:
 - (a) an ionic compound ⊕ charged metal ion + ⊖ charged non-metal ion (or polyatomic ion)
 - (b) a covalent compound 2+ non-metal atoms
2. Explain the following terms
 - (a) multivalent - an ion that can have more than 1 charge eg. Cu²⁺, Cu³⁺
 - (b) polyatomic - a group of covalently bonded atoms, where the whole molecule has an electric charge ⊕ or ⊖
 - (c) ratio of ions - the number of atoms of each in an ionic compound to balance charges = 0
 - (d) ~~multivalent~~ ionic compound to balance charges = 0
 - (e) cation - positively charged metal ion
 - (f) anion - negatively charged non-metal ion (or group of polyatomic ions)
3. List the prefixes used in covalent naming that represent the numbers 1 through 10.

1	2	3	4	5	6	7	8	9	10
mono-	di-	tri-	tetra-	pent-	hexa-	hepta-	octa-	nona-	deca-
4. Name each of the ions in the list below.

- | | | |
|--|---|------------------------------------|
| (a) Na ⁺ <u>sodium ion</u> | (b) SO ₄ ²⁻ <u>sulphate</u> | (d) CN ⁻ <u>cyanide</u> |
| (c) NH ₄ ⁺ <u>ammonium</u> | (e) V ⁴⁺ <u>vanadium (IV) ion</u> | (f) O ²⁻ <u>oxide</u> |

TEST YOURSELF:



Names and formulas of compounds

Match each Chemical Name on the left with the correct Chemical Formula on the right.

Chemical Name	Chemical Formula
1. <u>F</u> tin(II) chlorate	A. SnCl
2. <u>C</u> sulphur dichloride	B. S ₂ Cl
3. <u>I</u> strontium perchlorate	C. SnCl ₂
	D. SnClO
	E. Sn(ClO ₂) ₂
	F. Sn(ClO ₃) ₂
	G. Sn(ClO ₄) ₂
	H. Sr(ClO ₃) ₂
	I. Sr(ClO ₄) ₂

4. Which of the following is a covalent compound?

- A. ~~SrO~~ C. ~~SnO~~
 B. SeO₂ D. ~~Sr₂O₃~~
- 2 non-metals* (pointing to B) *metals* (pointing to A, C, D)

5. In which of the following do covalent bonds hold the atoms together?

- A. silver
 B. calcium carbonate
 C. silicon tetrafluoride
 D. magnesium bromide

6. What is the total number of atoms that make up iodine pentachloride?

- A. 2 C. 5
 B. 4 D. 6
- ICl₅*
1 + 5 = 6

7. Which of the following occurs when carbon forms a compound with oxygen?

- A. oxygen and carbon share electrons
 B. both oxygen and carbon lose electrons ~~x~~
 C. oxygen gains electrons, while carbon loses electrons ~~x~~
 D. carbon gains electrons, while oxygen loses electrons ~~x~~

*Carbon + oxygen
 => 2 non-metals
 => covalent bond
 ↳ share e⁻*

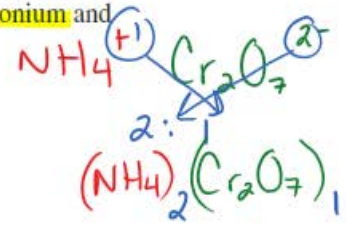
8. In the chemical reaction $\text{CuO} + \text{CO}_2 \rightarrow \text{CuCO}_3$, which of the following are ionic compounds?

I.	CO₂
II.	<u>CuO</u>
III.	<u>CuCO₃</u>

- A. I and II only C. II and III only
 B. I and III only D. I, II, and III

9. Which of the following is the formula for the compound formed by ammonium and dichromate?

- A. NH₄Cr₂O₇
 B. (NH₄)₂CrO₄
 C. NH₄(Cr₂O₇)₂
 D. (NH₄)₂Cr₂O₇



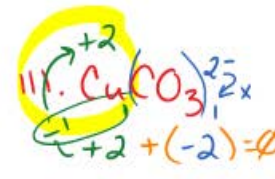
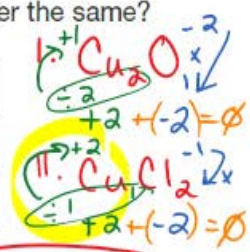
10. In which of the following compounds does manganese have the highest ion charge?

- A. MnO₃ C. MnSO₃⁻²
 B. MnBr₂⁻¹ D. Mn(OH)₂⁻¹

11. In which of the following compounds is the ion charge on copper the same?

I.	Cu ₂ O
II.	<u>CuCl₂</u>
III.	<u>CuCO₃</u>

- A. I and II only C. II and III only
 B. I and III only D. I, II, and III



12. In the name arsenic(III) chloride, what does the Roman numeral reveal about arsenic?

- A. it has an ion charge of 3-
 B. it has an ion charge of 3+ *metal*
 C. it has gained three electrons
 D. it can form three positive ions