

**Lesson 6 (2.4): Writing names and formulas for ionic and molecular compounds****Two types of compounds:**

Ionic compound – occurs when a metal loses all its valence electrons to a non-metal. The metal becomes a cation, while the non-metal becomes an anion.

Covalent compound – two non-metals share electrons. Neither loses or gains electrons – they share electrons. Neither atom becomes an ion.

Part I: How to name ionic compounds?**Rules for naming Binary ionic compound:**

1. The name of the metal ion is first, followed by the name of the non-metal ion.
2. The name of the metal ion is the same as the name of the metal atom.
3. If the metal is a transition metal, it might have more than one possible charge. In these cases, a roman numeral is written in brackets after the name of the metal to indicate the magnitude of the charge.
4. The name of the non-metal ion has the same root as the name of the atom, but the suffix is changed to **-ide**.

(common ionic charges in compounds)																	
1 H 1+	Nonmetals ↑ ↓ Metals																2 He n/a
3 Li 1+	4 Be 2+	Transition Metals										5 B n/a	6 C n/a	7 N 3-	8 O 2-	9 F 1-	10 Ne n/a
11 Na 1+	12 Mg 2+											13 Al 3+	14 Si n/a	15 P 3-	16 S 2-	17 Cl 1-	18 Ar n/a
19 K 1+	20 Ca 2+	21 Sc 3+	22 Ti 4+,3+,2+	23 V 5+,4+,3+,2+	24 Cr 6+,3+,2+	25 Mn 7+,4+,3+,2+	26 Fe 3+,2+	27 Co 3+,2+	28 Ni 3+,2+	29 Cu 2+,1+	30 Zn 2+	31 Ga 3+	32 Ge 4+,2+	33 As 5+,3+,3-	34 Se 2-	35 Br 1-	36 Kr n/a
37 Rb 1+	38 Sr 2+	39 Y 3+	40 Zr 4+	41 Nb 5+,3+	42 Mo 6+	43 Tc 7+,6+,4+	44 Ru 3+	45 Rh 3+	46 Pd 4+,2+	47 Ag 1+	48 Cd 2+	49 In 3+	50 Sn 4+,2+	51 Sb 5+,3+,3-	52 Te 6+,4+,2-	53 I 1-	54 Xe n/a
55 Cs 1+	56 Ba 2+	57 La 3+	72 Hf 4+	73 Ta 5+	74 W 6+	75 Re 7+,6+,4+	76 Os 4+,3+	77 Ir 4+,3+	78 Pt 4+,2+	79 Au 3+,1+	80 Hg 2+,1+	81 Tl 3+,1+	82 Pb 4+,2+	83 Bi 5+,3+	84 Po 4+,2+,2-	85 At 1+,1-	86 Rn n/a
87 Fr 1+	88 Ra 2+	89 Ac 3+	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	Not Yet Named			113	114	115	116	117	118

Example of transition metals: Mn^{4+} Manganese (IV) Fe^{2+} Iron (II) Cu^{1+} Copper (I)
 Mn^{6+} Manganese (VI) Fe^{3+} Iron (III) Cu^{2+} Copper (II)



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Example: Name the following compounds.

Fe_2O_2		Cu_3P_2	
$ZnCl_2$		PbS_2	
$AgCl$		MnO_2	

How about ionic compounds with polyatomic ions?

Valence = -1			
Ion	Name	Ion	Name
CN^-	cyanide	$H_2PO_3^-$	dihydrogen phosphite
CH_3COO^-	acetate	$H_2PO_4^-$	dihydrogen phosphate
ClO^-	hypochlorite	MnO_4^-	permanganate
ClO_2^-	chlorite	NO_2^-	nitrite
ClO_3^-	chlorate	NO_3^-	nitrate
ClO_4^-	perchlorate	OCN^-	cyanate
HCO_3^-	hydrogen carbonate	HS^-	hydrogen sulfide
HSO_3^-	hydrogen sulfite	OH^-	hydroxide
HSO_4^-	hydrogen sulfate	SCN^-	thiocyanate

Valence = -2			
Ion	Name	Ion	Name
CO_3^{2-}	carbonate	O_2^{2-}	peroxide
$C_2O_4^{2-}$	oxalate	SiO_3^{2-}	silicate
CrO_4^{2-}	chromate	SO_3^{2-}	sulfite
$Cr_2O_7^{2-}$	dichromate	SO_4^{2-}	sulfate
HPO_3^{2-}	hydrogen phosphite	$S_2O_3^{2-}$	thiosulfate
HPO_4^{2-}	hydrogen phosphate		

Valence = -3			
Ion	Name	Ion	Name
AsO_3^{3-}	arsenite	PO_3^{3-}	phosphite
AsO_4^{3-}	arsenate	PO_4^{3-}	phosphate

Prefix and suffix	Number of oxygen atoms
hypo _____ ite	x - 2 oxygen atoms
_____ ite	x - 1 oxygen atoms
_____ ate	x oxygen atoms
per _____ ate	x + 1 oxygen atoms

-ate -ite

Families of polyatomic ions

NO_3^-	NO_2^-		
PO_4^{3-}	PO_3^{3-}		
SO_4^{2-}	SO_3^{2-}		
ClO_4^-	ClO_3^-	ClO_2^-	ClO^-
BrO_4^-	BrO_3^-	BrO_2^-	BrO^-
IO_4^-	IO_3^-	IO_2^-	IO^-



Example: Name the following Ionic compounds write chemical formula by using cross over rule.

Cation	Anion	Compound	Name
Ca^{2+}	NO_3^-		
Mg^{2+}	PO_4^{3-}		
Ba^{2+}	SO_4^{2-}		

Part II: How to name covalent compounds?

Rules for naming Binary ionic compound:

1. Name the element with the lower group number first. Name the element with the higher group number second.
2. The one exception to the first rule occurs when oxygen is combined with a halogen. In this situation, the halogen is named first.
3. If both elements are in the same group, name the element with the higher period number first.
4. The name of the first element is unchanged.
5. To name the second element, use the root name of the element and add the suffix **-ide**.
6. If there are two or more atoms of the first element, add a prefix to indicate the number of atoms.
7. Always add a prefix to the name of the second element to indicate the number of atoms of this element in the compound.
(if the second element is oxygen, an "o" or "a" at the end of the prefix is usually omitted)

Example: Name these compounds:

Chemical formula	Name
CoF_2	
PCl_3	
Sr_3N_2	
KOH	
NH_3	

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



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Practice:

Write the formulas for the following covalent compounds:

- 1) antimony tribromide _____
- 2) hexaboron silicide _____
- 3) chlorine dioxide _____
- 4) hydrogen iodide _____
- 5) iodine pentafluoride _____
- 6) dinitrogen trioxide _____
- 7) ammonia _____
- 8) phosphorus triiodide _____

Write the names for the following covalent compounds:

- 9) P_4S_5 _____
- 10) O_2 _____
- 11) SeF_6 _____
- 12) Si_2Br_6 _____
- 13) SCl_4 _____
- 14) CH_4 _____
- 15) B_2Si _____
- 16) NF_3 _____

For each of the following questions, determine whether the compound is ionic or covalent and name it appropriately.

- 1) Na_2CO_3 _____
- 2) P_2O_5 _____
- 3) NH_3 _____
- 4) $FeSO_4$ _____
- 5) SiO_2 _____
- 6) $GaCl_3$ _____
- 7) $CoBr_2$ _____
- 8) B_2H_4 _____
- 9) CO _____
- 10) P_4 _____

For each of the following questions, determine whether the compound is ionic or covalent and write the appropriate formula for it.

- 11) dinitrogen trioxide _____
- 12) nitrogen _____
- 13) methane _____
- 14) lithium acetate _____
- 15) phosphorus trifluoride _____
- 16) vanadium (V) oxide _____



Exceptions to Naming rules

Peroxides (highly reactive):

- Compounds that contain an oxygen-oxygen single bond
- Oxygen has charge of – 1
- “per” = an extra oxygen atom

Steps for writing peroxides:

1. Write formula of oxide
2. Add one more oxygen
3. Do NOT cancel subscripts

Example: Write chemical formulas of the following compounds.

- a) sodium peroxide
- b) hydrogen peroxide
- c) barium peroxide

Hydrates:

- An ionic compound that contains loosely attached water molecules as part of its ionic crystal structure

For instance, when heat is applied to $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ (the hydrate), it will decompose to produce water vapour and the associated ionic compound (the anhydrate).

Step 1: Name the ionic compound.

Step 2: Indicate the number of water molecules using a Greek prefix in front of “hydrate”

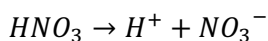
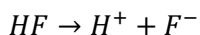
Example:

- a) $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$
- b) sodium carbonate decahydrate
- c) lithium chlorate trihydrate
- d) Iron (III) chloride hexahydrate

**Part III: How to name acids?**

Acid is a compound in which one or more hydrogen ions are bonded to a negative ion.

For example:



The name of acid is based on the name of the negative ion that is part of the acid.

Naming acids without oxygen

Take HCl as an example:

Negative ion	Acid
-ide	Hydro _____ic acid
Chloride	Hydrochloric acid

Negative Ions	
Fluoride	F^-
Chloride	Cl^-
Bromide	Br^-
Iodide	I^-
Oxide	O^{2-}
Sulfide	S^{2-}
Nitride	N^{3-}
Phosphide	P^{3-}

How about HBr :

Negative ion	Acid
-ide	Hydro _____ic acid
Bromide	Hydrobromic acid

Naming acids with oxygen (oxoacids)

How about $HClO$:

Negative ion	Acid
<i>hypo</i> -ite	-ous acid
Hypochlorite	Hypochlorous acid

How about $HClO_2$:

Negative ion	Acid
-ite	-ous acid
Chlorite	Chlorous acid



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How about HNO_2 :

Negative ion	Acid
-ite	-ous acid
Nitrite	Nitrous acid

Take HNO_3 as an example:

Negative ion	Acid
-ate	-ic acid
Nitrate	Nitric acid

How about H_2CO_3 :

Negative ion	Acid
-ate	-ic acid
Carbonate	Carbonic acid

How about H_2MnO_4 : (We call MnO_4^{2-} *manganate*,
Mn has charge of +6)

Negative ion	Acid
-ate	-ic acid
manganate	manganic acid

How about $HMnO_4$: (We call MnO_4^- *permanganate*,
Mn has charge of +7)

Negative ion	Acid
<i>per</i> -ate	-ic acid
Permanganate	Permanganic acid

<u>negative ion</u>	<u>acid</u>	<u>example</u>
-ide	hydro_____ic acid	chloride hydrochloric acid
-ate	-ic acid	nitrate nitric acid
-ite	-ous acid	nitrite nitrous acid

Important Exception!

<u>acids</u>	<u>negative ions</u>	
H_3PO_4	phosphate (PO_4^{3-})	phosphoric acid
H_3PO_3	phosphite (PO_3^{3-})	phosphorous acid
H_2SO_4	sulfate (SO_4^{2-})	sulfuric acid
H_2SO_3	sulfite (SO_3^{2-})	sulfurous acid