



Chemical Compounds

Bond Formation, Nomenclature, and Modelling

Overview

Review: atoms and subatomic particles, ions

Modelling Atoms and Compounds

- Counting Atoms
- Bohr Models
- Lewis Diagrams

IUPAC Naming and Writing Formulas

Balanced Chemical Equations

Section 3: IUPAC Nomenclature

(not covered in textbook)

Chemical Nomenclature (Naming)

It is important to have *one* system to name chemical compounds. Why?

- Scientists can communicate with each other and the public, even in different languages
- Every compound has a unique name
- Information/records are accurate and consistent

IUPAC (International Union of Pure and Applied Chemistry) came up with a naming scheme that is used around the world.

Identifying Elements, Ionic Compounds, and Covalent Compounds

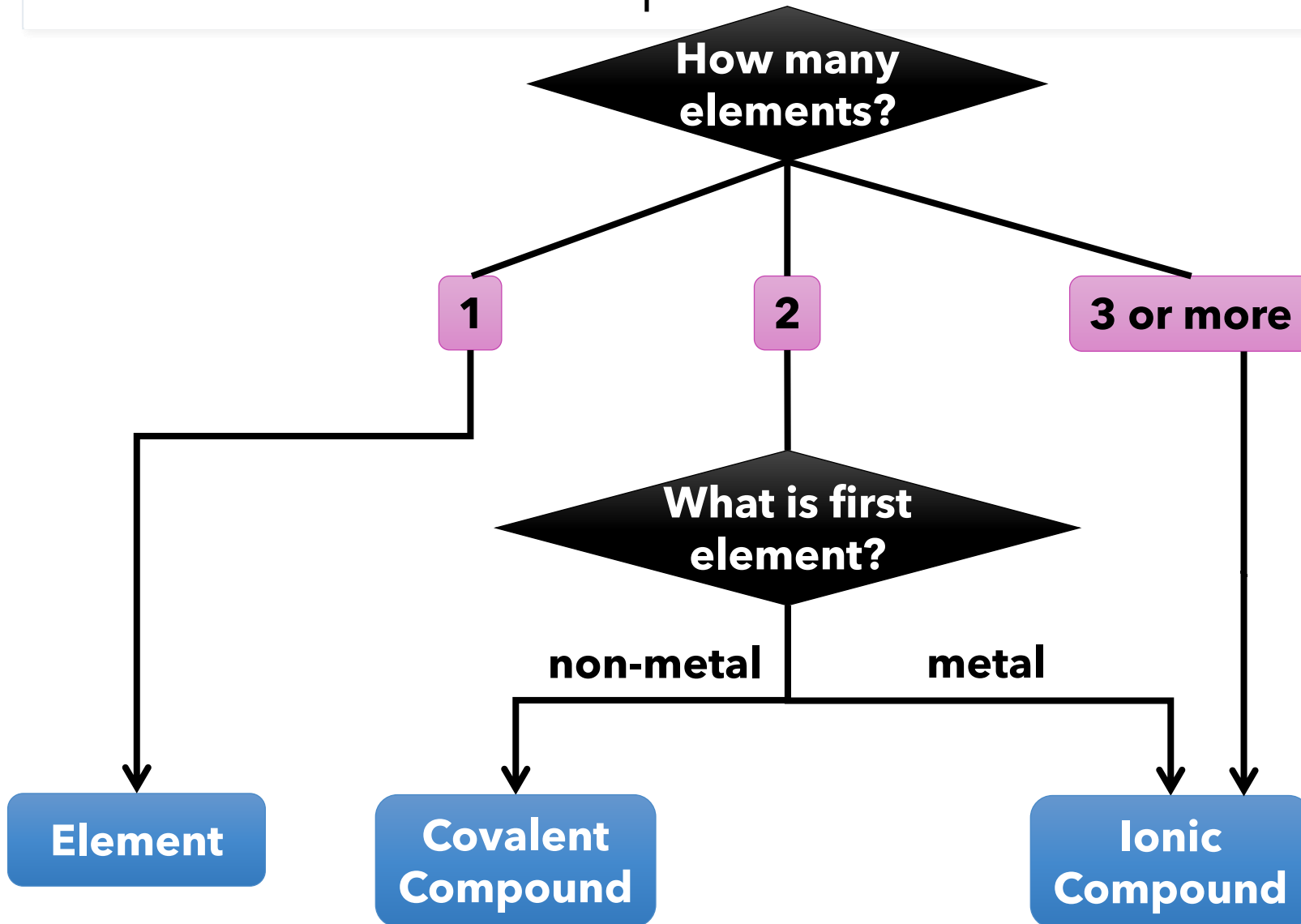
Identifying Elements, Ionic Compounds, Covalent Compounds

- Ionic compounds** form when **electrons are transferred** and ions are formed. Usually involves a **metal** and a **non-metal**.
- Covalent compounds** form when two (or more) **non-metal** atoms **share electrons**.

Atomic Number → 22 4+ ← Ion charge(s)
 Symbol → Ti
 Name → Titanium
 Atomic Mass → 47.9

1	2											13	14	15	16	17	18										
1 H Hydrogen 1.0																2 He Helium 4.0											
3 Li Lithium 6.9	4 Be Beryllium 9.0											5 B Boron 10.8	6 C Carbon 12.0	7 N Nitrogen 14.0	8 O Oxygen 16.0	9 F Fluorine 18.9	10 Ne Neon 20.1										
11 Na Sodium 23.0	12 Mg Magnesium 24.3	3 Sc Scandium 45.0	4 Ti Titanium 47.9	5 V Vanadium 50.9	6 Cr Chromium 52.0	7 Mn Manganese 54.9	8 Fe Iron 55.8	9 Co Cobalt 58.9	10 Ni Nickel 58.7	11 Cu Copper 63.5	12 Zn Zinc 65.4	13 Al Aluminum 27.0	14 Si Silicon 28.1	15 P Phosphorus 30.9	16 S Sulfur 32.1	17 Cl Chlorine 35.4	18 Ar Argon 39.9										
19 K Potassium 39.1	20 Ca Calcium 40.1	21 Sc Scandium 45.0	22 Ti Titanium 47.9	23 V Vanadium 50.9	24 Cr Chromium 52.0	25 Mn Manganese 54.9	26 Fe Iron 55.8	27 Co Cobalt 58.9	28 Ni Nickel 58.7	29 Cu Copper 63.5	30 Zn Zinc 65.4	31 Ga Gallium 69.7	32 Ge Germanium 72.6	33 As Arsenic 74.9	34 Se Selenium 79.0	35 Br Bromine 79.9	36 Kr Krypton 83.8										
37 Rb Rubidium 85.5	38 Sr Strontium 87.6	39 Y Yttrium 88.9	40 Zr Zirconium 91.2	41 Nb Niobium 92.9	42 Mo Molybdenum 95.9	43 Tc Technetium (98)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3										
55 Cs Cesium 132.9	56 Ba Barium 137.3	57 La Lanthanum 138.9	72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)										
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (272)	112 Uub Ununbium (285)	113 Uut Ununtrium (284)	114 Uuq Ununquadium (289)	115 Uup Ununpentium (288)	116 Uuh Ununhexium (292)	117 Uus Ununseptium (?)	118 Uuo Ununoctium (294)										
Alkali Metals		Alkaline Earth Metals												Halogens		Noble Gases											
Based on mass of C-12 at 12.00.																											
Any value in parentheses is the mass of the most stable or best known isotope for elements which do not occur naturally.																											
58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

Identifying Elements, Ionic Compounds, Covalent Compounds



In Science 9 and 10, you can use the following flowchart to tell apart elements and compounds based on their formulas.

(Note: in nature, many covalent compounds with 3+ elements exist; but we will not learn how to name them.)

The Cl Conundrum

Sometimes, Cl and Cl can look alike. Usually, it will refer to chlorine. Rarely, it will refer to carbon and iodine. When in doubt, ask!



Naming Elements



Naming Elements

An **element** is a pure substance containing **only one kind of atom**.

Examples:

- Mg (magnesium)
- Ca (calcium)

12	2+	20	2+
Mg		Ca	
Magnesium		Calcium	
24.3		40.1	

Names of elements are found on the **periodic table**.

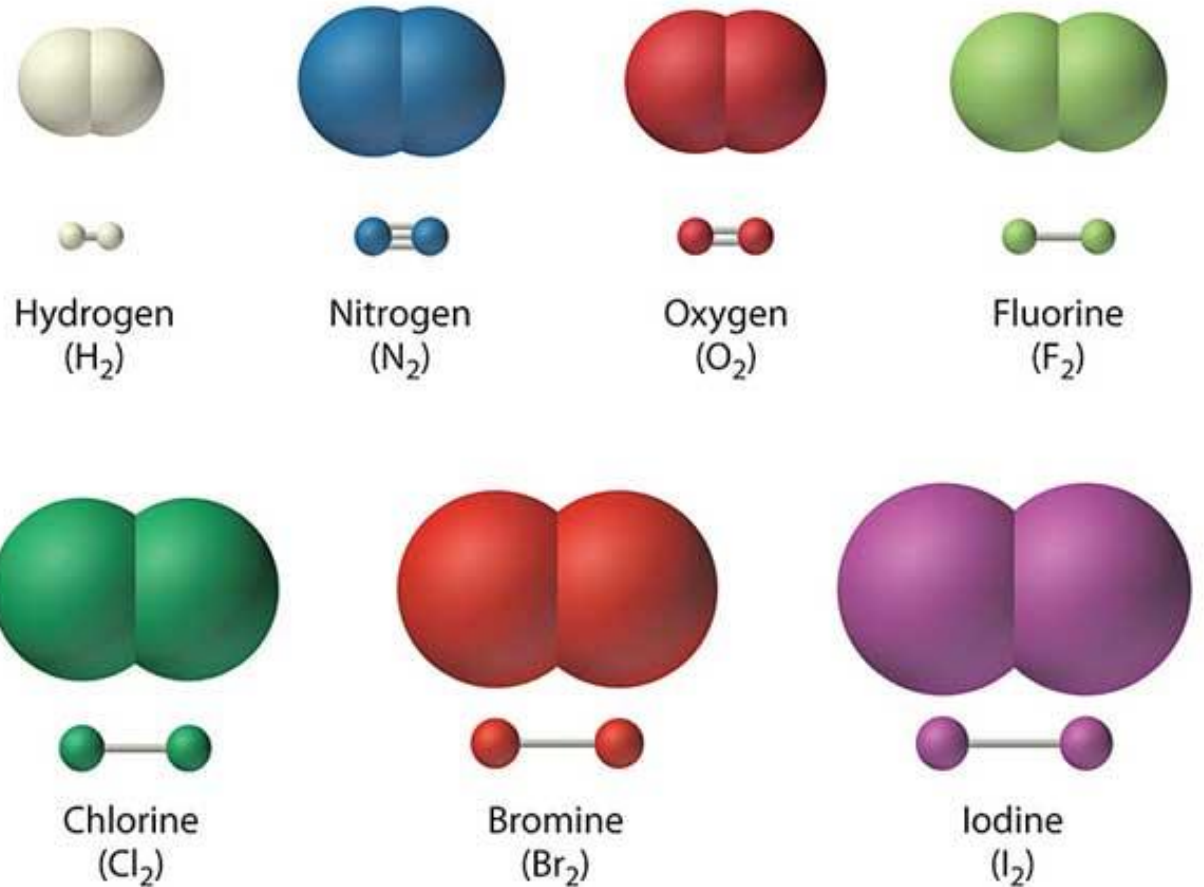
Ignore subscripts when naming.

- H₂ (hydrogen)
- Cl₂ (chlorine)

1	+	17	-
H		Cl	
Hydrogen		Chlorine	
1.0		35.5	

Revisiting Diatomic Elements

- When in their elemental (i.e. not in a compound) form, these elements exist as **diatomic molecules**: two atoms bonding covalently to fill their valence shells.
- Must memorize!



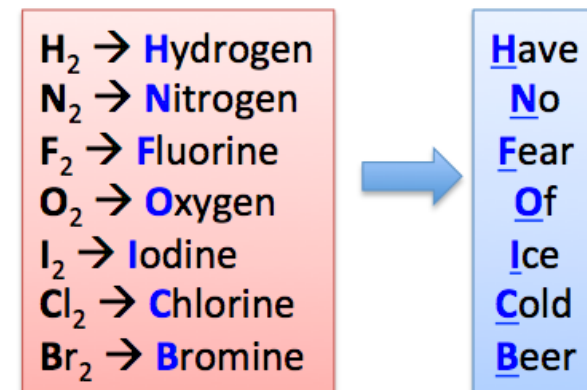
Revisiting Diatomic Elements

Memory aids:

- **HIBrONCIF**
 - **HOFB_rINCl**
 - **I Have No Bright Or Clever Friends**
 - **Have No Fear Of Ice Cold Beer**
 - **I Bring Cookies For Our New Home**
- ...or make your own!

1																	18																		
1	H																	2	He																
3	Li	4	Be											5	B	6	C	7	N	8	O	9	F	10	Ne										
11	Na	12	Mg	3	4	5	6	7	8	9	10	11	12	13	Al	14	Si	15	P	16	S	17	Cl	18	Ar										
19	K	20	Ca	21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr
37	Rb	38	Sr	39	Y	40	Zr	41	Nb	42	Mo	43	Tc	44	Ru	45	Rh	46	Pd	47	Ag	48	Cd	49	In	50	Sn	51	Sb	52	Te	53	I	54	Xe
55	Cs	56	Ba	57	La	72	Hf	73	Ta	74	W	75	Re	76	Os	77	Ir	78	Pt	79	Au	80	Hg	81	Tl	82	Pb	83	Bi	84	Po	85	At	86	Rn
87	Fr	88	Ra	89	Ac	104	Rf	105	Db	106	Sg	107	Bh	108	Hs	109	Mt	110	Ds	111	Rg	112	Cn	113	Nh	114	Fl	115	Mc	116	Lv	117	Ts	118	Og

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr



Naming Elements

1) Write the names of the following elements.

- | | | | |
|--------------------|-----------|-------------------|-----------|
| a. Na | sodium | e. O ₂ | oxygen |
| b. Br ₂ | bromine | f. Cu | copper |
| c. Mn | manganese | g. Ti | titanium |
| d. F ₂ | fluorine | h. Sr | strontium |

2) Write the formulas of the following elements.

- | | | | |
|-------------|----------------|---------------|-----------------|
| a. carbon | C | e. iodine | I ₂ |
| b. chromium | Cr | f. potassium | K |
| c. hydrogen | H ₂ | g. phosphorus | P |
| d. helium | He | h. chlorine | Cl ₂ |

Naming Ions

(not covered in textbook)

Reference

Non-metal Element	"-ide" Ending
N, nitrogen	Nitride
O, oxygen	Oxide
F, fluorine	Fluoride
P, phosphorus	Phosphide
S, sulfur	Sulfide

Non-metal Element	"-ide" Ending
Cl, chlorine	Chloride
Se, selenium	Selenide
Br, bromine	Bromide
I, iodine	Iodide
H, hydrogen	Hydride

Non-metal Element	"-ide" Ending
As, arsenic *	Arsenide
Te, tellurium *	Telluride
At, astatine *	Astatide

* uncommon

Different Types of Ions (Monovalent)

Monovalent ion:

- Can only make one ion (see periodic table)
- Cations: write name of element
- Anions: write name of element with "-ide" ending

Examples:

- Sodium ion = Na^+
- Yttrium ion = Y^{3+}
- Bromide ion = Br^-
- Oxide ion = O^{2-}

Different Types of Ions

Multivalent Ion:

- An element that can make multiple possible ions (see periodic table)
- Metals only
- Must specify charge with Roman numerals

Examples:

- manganese(III) = Mn^{3+}
- manganese(IV) = Mn^{4+}
- copper(I) = Cu^+
- vanadium(V) = V^{5+}

Note: manganese and magnesium are *different* elements!

Different Types of Ions

Polyatomic ion:

- Group of non-metal atoms *covalently* bonded with an ionic charge
- Spelling counts!!! (Copy from table)

Examples:

- NH_4^+ = ammonium ion
- PO_4^{3-} = phosphate ion
- PO_3^{3-} = phosphite ion

Polyatomic Ions

Note: Become familiar with these names so you can recognize them quickly in the future.

NAMES, FORMULAE AND CHARGES OF SOME POLYATOMIC IONS

Positive Ions	Negative Ions
NH_4^+ Ammonium	CH_3COO^- Acetate
	CO_3^{2-} Carbonate
	ClO_3^- Chlorate
	ClO_2^- Chlorite
	CrO_4^{2-} Chromate
	CN^- Cyanide
	$\text{Cr}_2\text{O}_7^{2-}$ Dichromate
	HCO_3^- Hydrogen carbonate, bicarbonate
	HSO_4^- Hydrogen sulfate, bisulfate
	HS^- Hydrogen sulfide, bisulfide

Positive Ions	Negative Ions
	HSO_3^- Hydrogen sulfite, bisulfite
	OH^- Hydroxide
	ClO^- Hypochlorite
	NO_3^- Nitrate
	NO_2^- Nitrite
	ClO_4^- Perchlorate
	MnO_4^- Permanganate
	PO_4^{3-} Phosphate
	PO_3^{3-} Phosphite
	SO_4^{2-} Sulfate
	SO_3^{2-} Sulfite

Practise

1) Write the names of the following monovalent ions.

a. Mg^{2+} magnesium

b. S^{2-} sulfide

c. Br^- bromide

d. K^+ potassium

e. O^{2-} oxide

f. N^{3-} nitride

g. Na^+ sodium

h. Sc^{3+} scandium

2) Write the names of the following multivalent ions.

a. Fe^{2+} iron(II)

b. Fe^{3+} iron(III)

c. Cu^{2+} copper(II)

d. Sn^{4+} tin(IV)

e. Au^{3+} gold(III)

f. Au^{1+} gold(I)

g. Ti^{4+} titanium(IV)

h. Mn^{3+} manganese(III)

Practise

3) Write the names of the following polyatomic ions.

- | | | | |
|---------------------|---------------------|-----------------------|------------------|
| a. CN^- | cyanide | e. HSO_4^- | bisulfate |
| b. ClO_4^- | perchlorate | f. PO_4^{3-} | phosphate |
| c. NO_3^- | nitrate | g. OH^- | hydroxide |
| d. MnO_4^- | permanganate | h. NH_4^+ | ammonium |

4) What is the charge of each of the following polyatomic ions?

- | | | | |
|---------------|-----------|-----------------------|-----------|
| a. dichromate | 2- | e. sulfate | 2- |
| b. carbonate | 2- | f. sulfite | 2- |
| c. bisulfide | 1- | g. chlorite | 1- |
| d. phosphite | 3- | h. hydrogen carbonate | 1- |

Practise

5) Name each of the following ions.

- a. Co^{3+} cobalt(III)
- b. Be^{2+} beryllium
- c. S^{2-} sulfide
- d. Cr^{2+} chromium(II)
- e. CrO_4^{2-} chromate
- f. P^{3-} phosphide
- g. V^{5+} vanadium(V)
- h. OH^- hydroxide

Remember: Roman numerals for multivalent metals ONLY.

Ionic Compound Nomenclature

(not covered in textbook)

Intro to Ionic Compound Nomenclature

Cation comes first; anion comes second.

Names of ionic compounds tell you *which ions* are in the compound.

e.g. "sodium chloride" has Na^+ and Cl^- ions.

e.g. "titanium(IV) dichromate" has Ti^{4+} and $\text{Cr}_2\text{O}_7^{2-}$ ions.

Chemical formulae tell you *how many of each ion* are in the compound, using subscripts.

e.g. " CaCl_2 " has 1 Ca^{2+} ion and 2 Cl^- ions.

e.g. " $\text{Mn}(\text{OH})_2$ " has 1 Mn^{4+} ion and 2 OH^- ions.

Naming Ionic Compounds

1. Write the **cation**, first.

For metals that can only form one ion (monovalent metals), do not write the ion charge.

For multivalent metals, determine the ion charge through **charge balancing**. Then, put the ion charge in **Roman numerals**, in brackets.

If the cation is polyatomic, write it exactly the way it is written in the table.

2. Write the anion with **"-ide" ending** (unless it is polyatomic).

Naming Ionic Compounds

1. Write the **cation**, first.

For metals that can only form one ion (monovalent metals), do not write the ion charge.

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Naming Ionic Compounds

1. Write the ***cation, first.***
2. Write the ***anion with "-ide" ending.***

Chemical Formula	Periodic Table	Name		
NaCl	<table border="1"><tr><td>11 + Na Sodium 23.0</td><td>17 - Cl Chlorine 35.5</td></tr></table>	11 + Na Sodium 23.0	17 - Cl Chlorine 35.5	
11 + Na Sodium 23.0	17 - Cl Chlorine 35.5			
MgBr₂	<table border="1"><tr><td>12 2+ Mg Magnesium 24.3</td><td>35 - Br Bromine 79.9</td></tr></table>	12 2+ Mg Magnesium 24.3	35 - Br Bromine 79.9	
12 2+ Mg Magnesium 24.3	35 - Br Bromine 79.9			

Your Turn!

Name the following ionic compounds with monovalent metals.

- a) **KI** **potassium iodide**
- b) **Be₃P₂** **beryllium phosphide**
- c) **ZnO** **zinc oxide**
- d) **BaF₂** **barium fluoride**
- e) **AlBr₃** **aluminium bromide**

Naming Ionic Compounds

1. Write the ***cation, first.***
2. Write the ***anion with "-ide" ending.***

Oh no! Chromium is multivalent.
Charge balancing is used to
find the charge of a
multivalent metal ion.

Chemical Formula	Periodic Table	Name																
Cr_2O_3	<table border="1"><tr><td>24</td><td>3+</td><td>8</td><td>2-</td></tr><tr><td>Cr</td><td>2+</td><td>O</td><td></td></tr><tr><td>Chromium</td><td></td><td>Oxygen</td><td></td></tr><tr><td>52.0</td><td></td><td>16.0</td><td></td></tr></table>	24	3+	8	2-	Cr	2+	O		Chromium		Oxygen		52.0		16.0		???
24	3+	8	2-															
Cr	2+	O																
Chromium		Oxygen																
52.0		16.0																
CrO		???																

Naming Ionic Compounds

1. Write the cation, first.

For metals that can only form one ion (monovalent metals), do not write the ion charge.

For multivalent metals, determine the ion charge through ***charge balancing***. Then, put the ion charge in ***Roman numerals***, in brackets.

2. Write the anion with “-ide” ending.

Charge Balancing (to find the charge of a **multivalent** metal ion)

- 1) Write out all the ions you have. Leave the charge blank on the multivalent metal.
- 2) Rule: *The total number of **positive** charges in an ionic compound must equal the total number of **negative** charges. Determine the charge on the metal ion.*
- 3) Write the compound name. Specify the ion charge on the multivalent metal using brackets and Roman numerals.

Charge Balancing Part 1: Determining Charges of Multivalent Metals

24 3+
Cr 2+
 Chromium
 52.0

8 2-
O
 Oxygen
 16.0

Cr ₂ O ₃ :	
1) Write out all the ions you have. Leave the charge blank on the multivalent metal.	<div style="display: flex; align-items: center; justify-content: center;"> <div style="margin-right: 20px;">Cr?</div> <div style="margin-right: 20px;">O²⁻</div> </div> <div style="display: flex; align-items: center; justify-content: center;"> <div style="margin-right: 20px;">Cr?</div> <div style="margin-right: 20px;">O²⁻</div> </div> <div style="display: flex; align-items: center; justify-content: center;"> <div style="margin-right: 20px;">Cr?</div> <div>O²⁻</div> </div>
2) <i>The total number of positive charges in an ionic compound must equal the total number of negative charges.</i> Determine the charge on the metal ion.	<div style="background-color: yellow; padding: 5px; border: 1px solid black; margin-bottom: 10px;"> <p>We know there are 2 chromium ions and 3 oxygen ions from the subscripts in the formula.</p> </div> <p>Total: 6 negative charges. Must have 6 positive to balance the charges. Divide by # of chromium ions (2). Therefore, each Cr ion must have a 3+ charge.</p>
3) Write the compound name. Specify the ion charge on the multivalent metal using brackets and Roman numerals.	chromium(III) oxide

Charge Balancing Part 1: Determining Charges of Multivalent Metals

24 3+
Cr 2+
Chromium
52.0

8 2-
O
Oxygen
16.0

CrO:	
1) Write out all the ions you have. Leave the charge blank on the multivalent metal.	Cr? O ²⁻ <div style="background-color: yellow; padding: 5px; display: inline-block;">We know there is 1 chromium ion and 1 oxygen ion from the subscripts in the formula.</div>
2) <i>The total number of positive charges in an ionic compound must equal the total number of negative charges.</i> Determine the charge on the metal ion.	Total: 2 negative charges. Must have 2 positive to balance the charges. Divide by # of chromium ions (1). Therefore, each Cr ion must have a 2+ charge.
3) Write the compound name. Specify the ion charge on the multivalent metal using brackets and Roman numerals.	chromium(II) oxide

Your Turn!

Name the following ionic compounds with multivalent metals.

- a) **TiO₂** **titanium(IV) oxide**
- b) **Mo₂S₃** **molybdenum(III) sulfide**
- c) **Hg₃P** **mercury(I) phosphide**
- d) **MnSe₂** **manganese(IV) selenide**
- e) **SnI₂** **tin(II) iodide**

Your Turn!

Name the following ionic compounds. Make sure you do charge balancing for ionic compounds with multivalent metals only.

1) Who wants to take a **Na₃P**?

2) Better **FeS** up.

3) Is your name **Be₃N₂**?

4) Who **AmI₆**?

5) "Vegetable" in Chinese is **CaI₂**.

Your Turn!

Name the following ionic compounds. Make sure you do charge balancing for ionic compounds with multivalent metals only.

- 1) Who wants to take a **Na₃P**? **sodium phosphide**
- 2) Better **FeS** up. **iron(II) sulfide**
- 3) Is your name **Be₃N₂**? **beryllium nitride**
- 4) What about **AmI₆**? **americium(VI) iodide**
- 5) “Vegetable” in Chinese is **CaI₂**. **calcium iodide**

Naming Ionic Compounds

1. Write the cation, first.

For metals that can only form one ion (monovalent metals), do not write the ion charge.

For multivalent metals, determine the ion charge through charge balancing. Then, put the ion charge in Roman numerals, in brackets.

If the cation is polyatomic, write it exactly the way it is written in the table.

2. Write the anion with “-ide” ending (*unless it is polyatomic.*)

Polyatomic Ions

Note: Become familiar with these names so you can recognize them quickly in the future.

NAMES, FORMULAE AND CHARGES OF SOME POLYATOMIC IONS

Positive Ions	Negative Ions
NH_4^+ Ammonium	CH_3COO^- Acetate
	CO_3^{2-} Carbonate
	ClO_3^- Chlorate
	ClO_2^- Chlorite
	CrO_4^{2-} Chromate
	CN^- Cyanide
	$\text{Cr}_2\text{O}_7^{2-}$ Dichromate
	HCO_3^- Hydrogen carbonate, bicarbonate
	HSO_4^- Hydrogen sulfate, bisulfate
	HS^- Hydrogen sulfide, bisulfide

Positive Ions	Negative Ions
	HSO_3^- Hydrogen sulfite, bisulfite
	OH^- Hydroxide
	ClO^- Hypochlorite
	NO_3^- Nitrate
	NO_2^- Nitrite
	ClO_4^- Perchlorate
	MnO_4^- Permanganate
	PO_4^{3-} Phosphate
	PO_3^{3-} Phosphite
	SO_4^{2-} Sulfate
	SO_3^{2-} Sulfite

Naming with Polyatomic Ions: Examples

Chemical Formula	Periodic Table	Name																
Mg(OH)₂	<table border="1"> <tr> <td>12</td> <td>2+</td> <td>HSO₃⁻</td> <td>Hydrogen sulfite, bisulfite</td> </tr> <tr> <td>Mg</td> <td></td> <td>OH⁻</td> <td>Hydroxide</td> </tr> <tr> <td>Magnesium</td> <td></td> <td>ClO⁻</td> <td>Hypochlorite</td> </tr> <tr> <td>24.3</td> <td></td> <td></td> <td></td> </tr> </table>	12	2+	HSO ₃ ⁻	Hydrogen sulfite, bisulfite	Mg		OH ⁻	Hydroxide	Magnesium		ClO ⁻	Hypochlorite	24.3				magnesium hydroxide
12	2+	HSO ₃ ⁻	Hydrogen sulfite, bisulfite															
Mg		OH ⁻	Hydroxide															
Magnesium		ClO ⁻	Hypochlorite															
24.3																		
(NH₄)₂S	<table border="1"> <tr> <td colspan="2">Positive Ions</td> <td>16</td> <td>2-</td> </tr> <tr> <td colspan="2">NH₄⁺ Ammonium</td> <td>S</td> <td></td> </tr> <tr> <td colspan="2"></td> <td>Sulfur</td> <td></td> </tr> <tr> <td colspan="2"></td> <td>32.1</td> <td></td> </tr> </table>	Positive Ions		16	2-	NH ₄ ⁺ Ammonium		S				Sulfur				32.1		ammonium sulfide
Positive Ions		16	2-															
NH ₄ ⁺ Ammonium		S																
		Sulfur																
		32.1																

Naming with Polyatomic Ions: Examples

Chemical Formula	Periodic Table	Name						
$\text{Sc}(\text{HSO}_3)_3$	<div style="background-color: #d9e1f2; padding: 5px; margin-bottom: 10px;"> 21 3+ Sc Scandium 45.0 </div> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">HSO_4^-</td> <td style="padding: 5px;">Hydrogen sulfate, bisulfate</td> </tr> <tr> <td style="padding: 5px;">HS^-</td> <td style="padding: 5px;">Hydrogen sulfide, bisulfide</td> </tr> <tr> <td style="padding: 5px;">HSO_3^-</td> <td style="padding: 5px;">Hydrogen sulfite, bisulfite</td> </tr> </table>	HSO_4^-	Hydrogen sulfate, bisulfate	HS^-	Hydrogen sulfide, bisulfide	HSO_3^-	Hydrogen sulfite, bisulfite	<ol style="list-style-type: none"> 1. scandium hydrogen sulfite <i>OR</i> 2. scandium bisulfite <p style="margin-top: 20px;">scandium hydrogen sulfite, bisulfite</p>
HSO_4^-	Hydrogen sulfate, bisulfate							
HS^-	Hydrogen sulfide, bisulfide							
HSO_3^-	Hydrogen sulfite, bisulfite							

Naming with Polyatomic Ions: Examples

22	4+
Ti	3+
Titanium	
47.9	

ClO_2^-	Chlorite
CrO_4^{2-}	Chromate
CN^-	Cyanide

$\text{Ti}_2(\text{CrO}_4)_3$	
<p>1) Write out all the ions you have. Leave the charge blank on the multivalent metal.</p>	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">Ti?</div> <div style="text-align: center;">CrO_4^{2-}</div> </div> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">Ti?</div> <div style="text-align: center;">CrO_4^{2-}</div> <div style="text-align: center;">CrO_4^{2-}</div> </div>
<p>2) <i>The total number of positive charges in an ionic compound must equal the total number of negative charges.</i> Determine the charge on the metal ion.</p>	<p>Total: 6 negative charges. Must have 6 positive to balance the charges. Divide by # of titanium ions (2). Therefore, each Ti ion must have a 3+ charge.</p>
<p>3) Write the compound name. Specify the ion charge on the multivalent metal using brackets and Roman numerals. Spell the polyatomic ion exactly as it is spelled in the reference sheet.</p>	<h2 style="margin: 0;">titanium(III) chromate</h2>

Your Turn!

Name the following ionic compounds with polyatomic ions.

- a) $\text{Ca}(\text{OH})_2$ **calcium hydroxide**
- b) $\text{Zn}(\text{ClO}_4)_2$ **zinc perchlorate**
- c) $(\text{NH}_4)_2\text{O}$ **ammonium oxide**
- d) $\text{Ti}_3(\text{PO}_3)_4$ **titanium(IV) phosphite**
- e) HgHSO_4 **mercury(I) bisulfate *or***
mercury(I) hydrogen sulfate

Writing Formulas of Ionic Compounds

(not covered in textbook)

Intro to Ionic Compound Nomenclature

Names of ionic compounds tell you *which ions* are in the compound. The cation comes first; the anion comes second.

To write a chemical formula of an ionic compound, you must find out how many of each ion is involved, through **charge balancing**.

Rule: The total number of positive charges in an ionic compound must equal the total number of negative charges.

Writing Formulas of Ionic Compounds (v1)

1. Write down each ion with its charge.
2. Add more of the ions to balance the charges: the total number of positive and negative charges must be equal.
3. Write your formula with subscripts.

To indicate more than one of a polyatomic ion, use brackets with the subscript outside.

Writing Chemical Formulas: Examples (v1)

20 2+

Ca

Calcium

40.1

15 3-

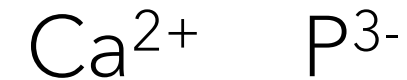
P

Phosphorus

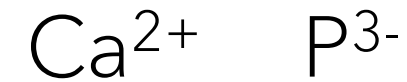
31.0

calcium phosphide

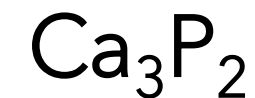
1) Write down each ion with its charge.



2) Add more of the ions to balance the charges: the total number of positive and negative charges must be equal.



3) Write your formula with subscripts.



Writing Chemical Formulas: Examples (v1)

24	3+
Cr	2+
Chromium	
52.0	

HSO_3^- Hydrogen sulf

OH^- Hydroxide

ClO^- Hypochlorite

chromium(II) hydroxide

1) Write down each ion with its charge.



2) Add more of the ions to balance the charges: the total number of positive and negative charges must be equal.



3) Write your formula with subscripts.



Writing Chemical Formulas: Practice (v1)

1) Use "Version 1" to write the chemical formulas of these compounds.

a) calcium nitride



b) copper(II) iodide



c) aluminium nitride



d) manganese(IV) sulfate



Writing Formulas of Ionic Compounds (v2)

1. Write down each ion with its charge.
2. Write the chemical formula by writing the cation first and the anion second. Then, "criss-cross" the charges to become the subscripts.
3. Reduce the subscripts if both divisible by the same number.

Writing Chemical Formulas: Examples (v2)

20 2+

Ca

Calcium

40.1

15 3-

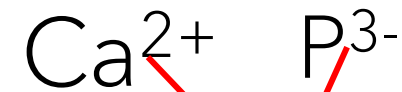
P

Phosphorus

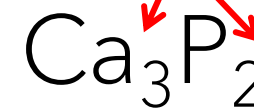
31.0

calcium phosphide

1) Write down each ion with its charge.



2) Write the chemical formula by writing the cation first and the anion second. Then, "criss-cross" the charges to become the subscripts.



3) Reduce the subscripts if both divisible by the same number.

2 and 3 do not have a common factor. Therefore, **Ca₃P₂** is our final answer.

Writing Chemical Formulas: Examples (v2)

24	3+
Cr	2+
Chromium	
52.0	

HSO_3^- Hydrogen sulf

OH^- Hydroxide

ClO^- Hypochlorite

chromium(II) hydroxide

1) Write down each ion with its charge.



2) Write the chemical formula by writing the cation first and the anion second. Then, "criss-cross" the charges to become the subscripts.



3) Reduce the subscripts if both divisible by the same number.

1 and 2 do not have a common factor. Therefore, $\text{Cr}(\text{OH})_2$ is our final answer.

Writing Chemical Formulas: Examples (v2)

12 2+

Mg

Magnesium

24.3

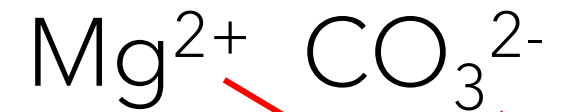
CH₃COO⁻ Acetate

CO₃²⁻ Carbonate

ClO₃⁻ Chlorate

magnesium carbonate

1) Write down each ion with its charge.



2) Write the chemical formula by writing the cation first and the anion second. Then, "criss-cross" the charges to become the subscripts.



3) Reduce the subscripts if both divisible by the same number.

2 and 2 are both divisible by 2. Rewrite formula as **MgCO₃**.

Writing Chemical Formulas: Examples (v2)

25 2+
Mn 3+
Manganese 4+
54.9

PO_3^{3-} Phosphite

SO_4^{2-} Sulfate

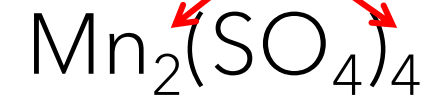
SO_3^{2-} Sulfite

manganese(IV) sulfate

1) Write down each ion with its charge.



2) Write the chemical formula by writing the cation first and the anion second. Then, "criss-cross" the charges to become the subscripts.



3) Reduce the subscripts if both divisible by the same number.

4 and 2 are both divisible by 2. Rewrite formula as $\text{Mn}(\text{SO}_4)_2$.

Writing Chemical Formulas: Practice (v1)

2) Use "Version 2" to write the chemical formulas of these compounds.

a) cadmium phosphide



b) chromium(III) oxide



c) rhodium(IV) sulfide



d) strontium carbonate



Naming and Writing Formulas: Covalent Compounds

(not covered in textbook)

Naming Binary Covalent Compounds

Binary covalent compound: a covalent compound containing only two elements

Names and formulas of covalent compounds *both* tell you:

- Which elements?
- How many atoms of each element?

Example: **dichlorine monoxide** is **Cl₂O**

Prefixes Reference

PREFIXES

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

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

Naming Binary Covalent Compounds

1. Write the first element.
2. Write the second element with **"-ide" ending**.
3. Add **prefixes** to show how many of each element there is.
 - Do not add **"mono-"** to first element.
 - If adding "mono-" to "-oxide", write **"monoxide"** instead.

e.g. O_2F_2

di oxygen di fluoride

e.g. PF_3

phosphorus tri fluoride

e.g. N_2O

di nitrogen mon oxide

Note: All compound names (covalent *and* ionic) are lowercase.

More Practice: Binary Covalent Compounds

Chemical Formula	Compound Name
S₂O₅	
Cl₃O₇	
CBr₂	
NO	
CCl₄	
P₂S₆	

Naming Binary Covalent Compounds

Covalent compounds with special names (must memorize):

NH_3 = ammonia

H_2O = water

CH_4 = methane

NH_4^+ (ammonium ion)
and NH_3 (ammonia)
are ***not the same!!!***

Chemical Formulas of Binary Covalent Compounds

1. Identify the elements involved. Write their **symbols**.
2. Use the **prefixes** to determine the number of each element in the compound. Write as **subscripts**.

e.g. tetraphosphorus pentoxide



e.g. nitrogen triiodide



e.g. selenium difluoride



More Practice: Binary Covalent Compounds

Chemical Formula

Compound Name

nitrogen trioxide

triphosphorus tetraoxide

iodine pentafluoride

tricarbon disulfide

boron trifluoride

xenon hexafluoride

Resources

- Naming and Writing Chemical Formulas
 - Tyler DeWitt Videos <https://www.youtube.com/user/tdewitt451/videos>
 - Mr. Carman's Blog (generates quizzes) <https://www.kentschools.net/ccarman/cp-chemistry/practice-quizzes/compound-naming/>
 - Mr. Eisley (list of other resources to practice) <http://www.mreisley.com/nomenclature-practice.html>
 - ChemFiesta (worksheets with answers) <https://chemfiesta.org/2015/01/13/naming-worksheets/>
- Balancing Chemical Equations
 - TemplateLAB (explanations and many worksheets with answers) <https://templatelab.com/balancing-equations-worksheet/>