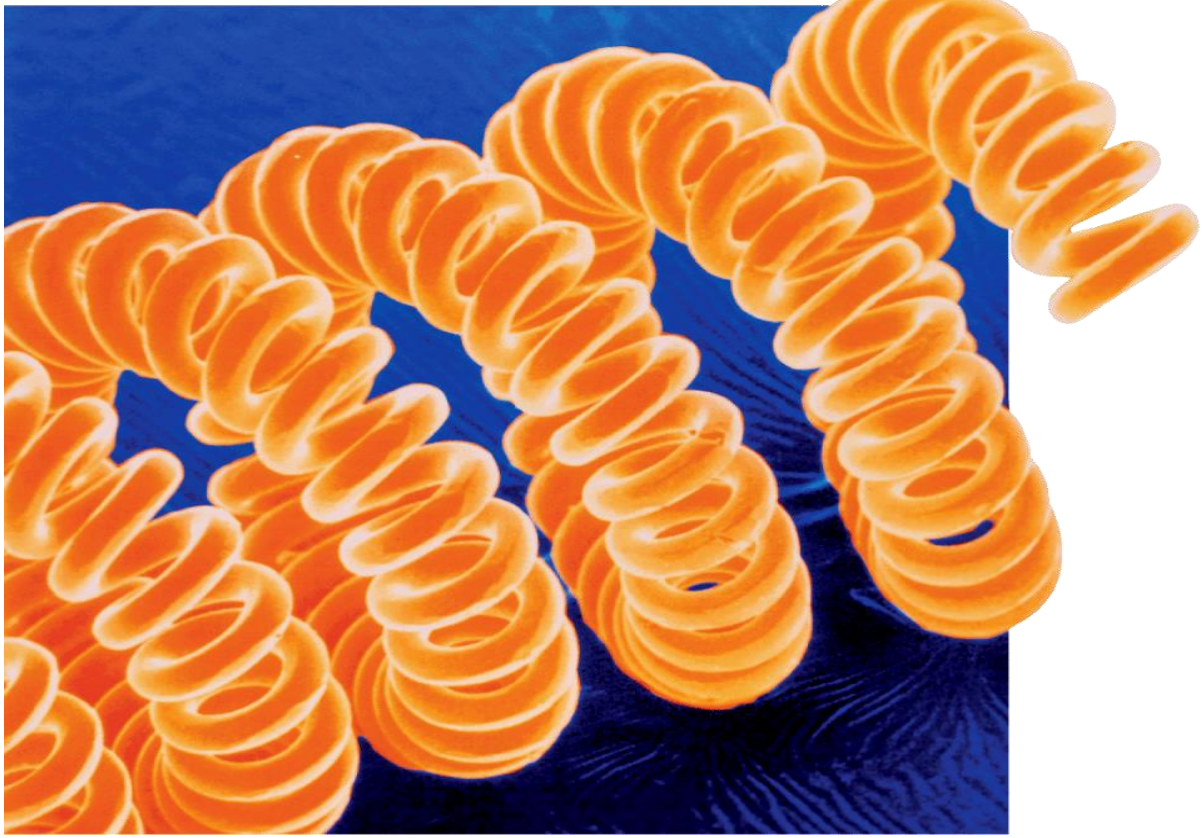


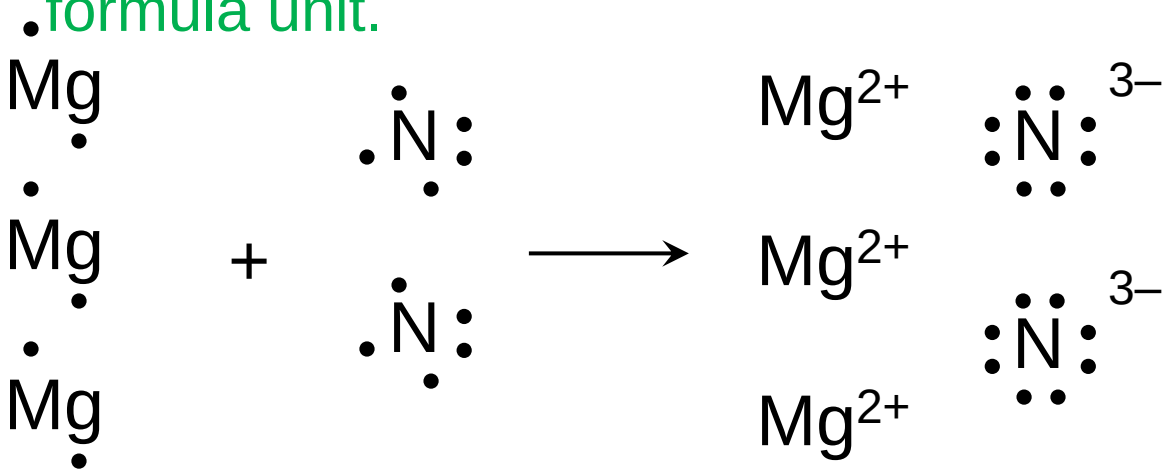
Chemical Bonding

Practice Questions

Use electron dot diagrams to determine the formula of the ionic compound formed when magnesium reacts with nitrogen. Show the overall charge on the formula unit.

QUICK CHECK

Use electron dot diagrams to determine the formula of the ionic compound formed when magnesium reacts with nitrogen. Show the overall charge on the formula unit.



Criss-Cross:

$Mg^{+2}N^{-3}$

Mg_3N_2

Overall Charge = 3(+2) + 2(-3) = **0**

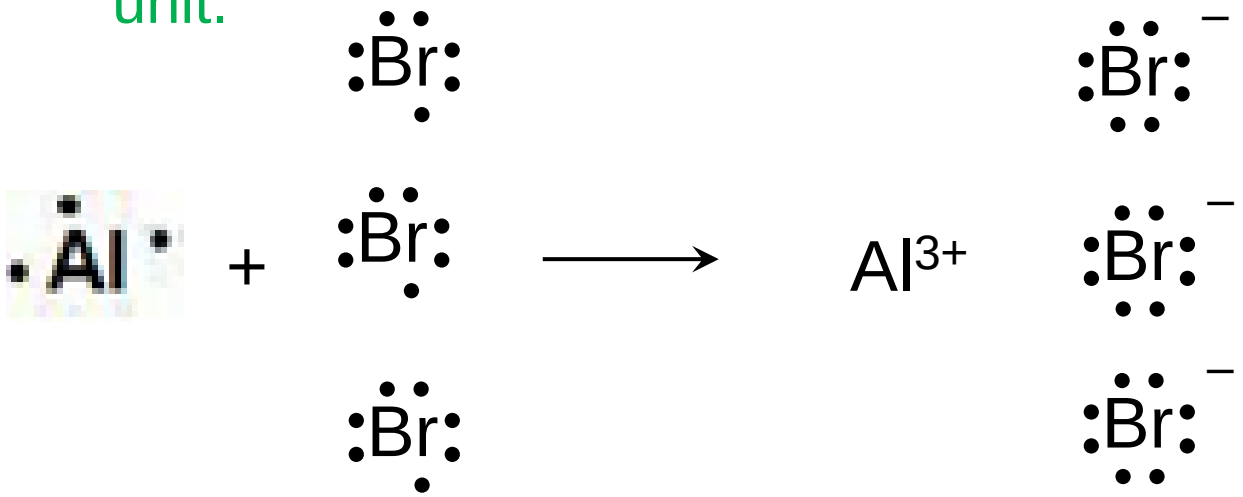
All the atoms have a full valence.

QUICK CHECK

Use *electron dot diagrams* to determine the formula of the ionic compound formed when aluminum reacts with Bromine. Show the overall charge on the formula unit.

QUICK CHECK

Use *electron dot diagrams* to determine the formula of the ionic compound formed when aluminum reacts with Bromine. Show the overall charge on the formula unit.



$AlBr_3$

Criss-Cross:

$Al^{+3}Br^{-}$

Overall Charge = +3 + 3(-1) = **0**

All the atoms have a full valence.

Write the Chemical Formulas from the Name

sodium phosphate

ammonium carbonate

TRY IT

Write the Chemical Formulas from the Name

sodium phosphate

Sodium: Na^+ Phosphate: PO_4^{3-}

(3)(+1) + (–3) = 0

$Na_3^+(PO_4)^{3-}$

$Na^+(PO_4)^{3-}$

ammonium carbonate

Ammonium: NH_4^+ Carbonate: CO_3^{2-}

(2)(+1) + (–2) = 0

$(NH_4)_2^+(CO_3)^{-2}$

$NH_4^+(CO_3)^{2-}$

QUICK CHECK

Bonding Elements	Name of Compound
Sodium + Sulfur	
Calcium + Fluorine	
Oxygen + Silver	
Chlorine + Magnesium	
Lithium + Nitrogen	
Strontium + Sulfur	
Barium + Bromine	
Oxygen + Potassium	
Copper (+2) + Sulfur	
Copper (+1) + Sulfur	
Iron (+2) + Oxygen	
Iron (+3) + Oxygen	

QUICK CHECK

Bonding Elements	Name of Compound
Sodium + Sulfur	Sodium sulfide
Calcium + Fluorine	Calcium fluoride
Oxygen + Silver	Silver oxide (*Ag only has 1 oxid. #)*
Chlorine + Magnesium	Magnesium chloride
Lithium + Nitrogen	Lithium nitride
Strontium + Sulfur	Strontium sulfide
Barium + Bromine	Barium bromide
Oxygen + Potassium	Potassium oxide
Copper (+2) + Sulfur	Copper(II) sulfide, cupric sulfide
Copper (+1) + Sulfur	Copper(I) sulfide, cuprous sulfide
Iron (+2) + Oxygen	Iron(II) oxide, Ferrous Oxide
Iron (+3) + Oxygen	Iron(III) oxide, Ferric Oxide

Which of these formulas describes a binary ionic compound?

a. O_2
b. $MgCl_2$
c. NO_2
d. $Fe(OH)_3$

What is the correct name for CCl_4?

a. carbon(IV) chloride
b. carbon tetrachlorine
c. carbon tetrachloride
d. monocarbon tetrachloride

Write the formula for the compound calcium oxide.

Which of these formulas describes a binary ionic compound?

a. O_2 **(diatomic, covalent)**
b. **$MgCl_2$ (binary means "two" elements only)**
c. NO_2 **(covalent)**
d. $Fe(OH)_3$ **(ionic, but not binary)**

What is the correct name for CCl_4?

a. carbon(IV) chloride
b. carbon tetrachlorine
c. **carbon tetrachloride (1 carbon, 4 chlorines)**
d. monocarbon tetrachloride

Write the formula for the compound calcium oxide.

It takes one calcium ion with a charge of 2+ to balance one oxide ion with a charge of 2–. The formula is CaO.

What force holds the atoms of a metal together?

a. the attraction of a positively charged atom to a negatively charged atom
b. the attraction between metal cations and a pool of shared electrons
c. the sharing of electrons between two atoms
d. the gravitational force between dense metal atoms

Why are solid metals good conductors of electric current?

a. Metals are good conductors because they can be drawn into wires.
b. Metals are good conductors because they are solids at room temperature.
c. The nuclei of metal atoms can move easily because they repel one another.
d. Shared electrons are able to flow freely through the metal.

The properties of steel depend on the ratio of iron, carbon, and small amounts of other elements in the _____.

What force holds the atoms of a metal together?

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b. the attraction between metal cations and a pool of shared electrons

c. the sharing of electrons between two atoms

d. the gravitational force between dense metal atoms

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The properties of steel depend on the ratio of iron, carbon, and small amounts of other elements in the **alloy**.

Write the Chemical Formulas (Use Criss Cross Method, showing cations/anions)

Sodium oxide

Barium phosphide

Potassium chloride

Lithium sulfide

Copper(I) nitrate

Manganese(IV) sulfate

Ammonium phosphate

Cobalt(II) chloride

Write the Chemical Formulas (Use Criss Cross Method, showing cations/anions)

Sodium oxide

$Na_2^{+}O^{-2} \rightarrow Na_2O$

Barium phosphide

$Ba_3^{+2}P_2^{-3} \rightarrow Ba_3P_2$

Potassium chloride

$K^{+}Cl^{-} \rightarrow KCl$

Lithium sulfide

$Li_2^{+}S^{-2} \rightarrow Li_2S$

Copper(I) nitrate

$Cu^{+}(NO_3)^{-} \rightarrow Cu(NO_3)$

Manganese(IV) sulfate

$Mn_2^{+4}(SO_4)_4^{-2} \rightarrow Mn(SO_4)_2$

Ammonium phosphate

$(NH_4)_3^{+}(PO_4)^{-3} \rightarrow (NH_4)_3(PO_4)$

Cobalt(II) chloride

$Co^{+2}Cl_2^{-2} \rightarrow CoCl_2$

Ionic compounds do not need special naming, but transition elements do.

Name the Following Ionic Compounds

$MgCl_2$

B_2O_3

CsF

BaS

Na_3N

$Fe_2(SO_4)_3$

$Mn(NO_3)_2$

Cu_2CO_3

NH_4I

Na_3PO_4

Name the Following Ionic Compounds

$MgCl_2$

magnesium chloride

B_2O_3

boron oxide

CsF

cesium fluoride

BaS

barium sulfide

Na_3N

sodium nitride

$Fe_2^{+3}(SO_4)_3$

iron(III) sulfate, Ferric sulfate

$Mn^{+2}(NO_3)_2$

manganese(II) nitrate

$Cu_2^{+1}CO_3$

copper(I) carbonate,
cuprous carbonate

NH_4I

ammonium iodide

Na_3PO_4

sodium phosphate

Ionic compounds do not need special naming, but transition elements do.

Polyatomic Ions

Name	Formula	Name	Formula
perPhosphate	$(PO_5)^{-3}$	perCarbonate	$(CO_4)^{-2}$
Phosphate	$(PO_4)^{-3}$	**Carbonate**	$(CO_3)^{-2}$
Phosphite	$(PO_3)^{-3}$	Carbonite	$(CO_2)^{-2}$
hypoPhosphite	$(PO_2)^{-3}$	hypocarbonite	$(CO)^{-2}$
perChlorate	$(ClO_4)^{-1}$	perNitrate	$(NO_4)^{-}$
Chlorate	$(ClO_3)^{-1}$	**Nitrate**	$(NO_3)^{-}$
Chlorite	$(ClO_2)^{-1}$	Nitrite	$(NO_2)^{-}$
hypoChlorite	$(ClO)^{-1}$	Hyponitrite	$(NO)^{-}$
perSulfate	$(SO_5)^{-2}$	perChromate	$(CrO_5)^{-2}$
Sulfate	$(SO_4)^{-2}$	**Chromate**	$(CrO_4)^{-2}$
Sulfite	$(SO_3)^{-2}$	Chromite	$(CrO_3)^{-2}$
hyposulfite	$(SO_2)^{-2}$	Hypochromite	$(CrO_2)^{-2}$
Acetate	$(C_2H_3O_2)^{-1}$	**Cyanide**	$(CN)^{-1}$
Hydroxide	$(OH)^{-1}$	**Manganate**	$(MnO_4)^{-2}$

Ammonium
$(NH_4)^{+1}$

Compounds With Polyatomic Ions

TRY IT

Determine the formula: use the criss-cross method with polyatomic ions, treating the polyatomic ion as ONE unit:

Calcium nitrate

Lithium Carbonate

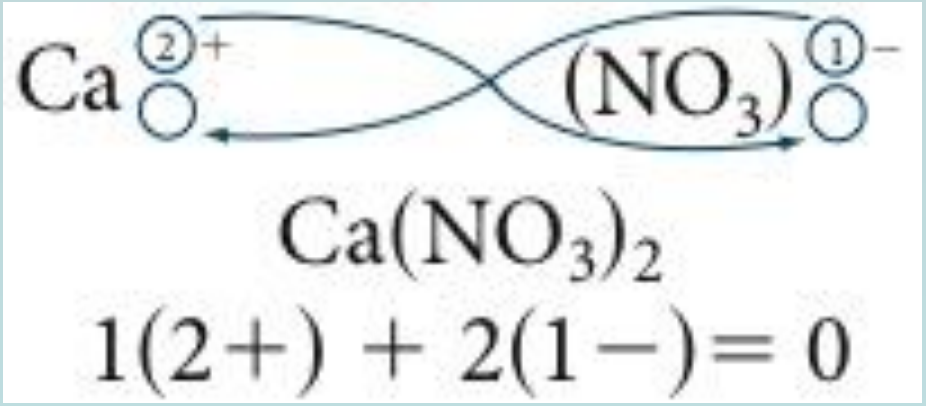
Magnesium Hydroxide

Compounds With Polyatomic Ions

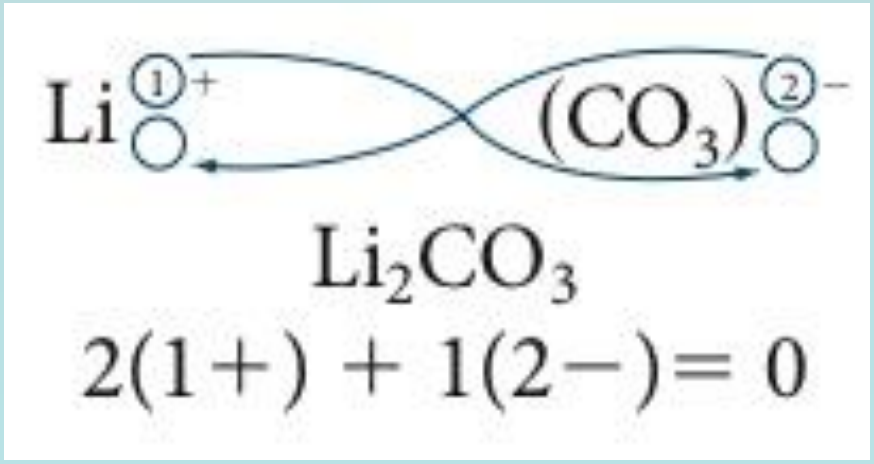
TRY IT

Determine the formula: use the criss-cross method with polyatomic ions, treating the polyatomic ion as ONE unit:

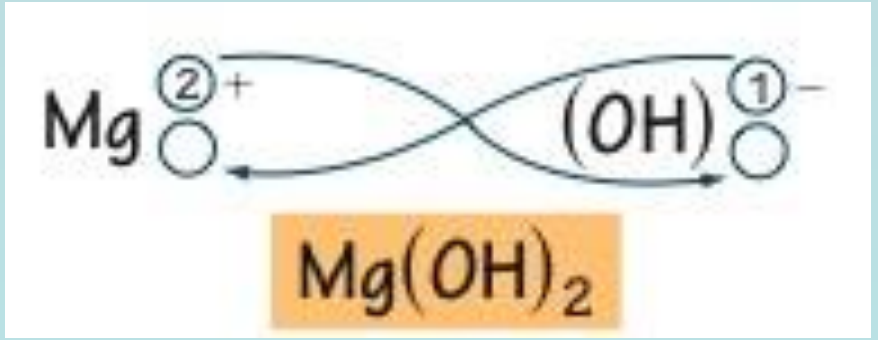
Calcium nitrate



Lithium Carbonate



Magnesium Hydroxide



1(2+) + 2(1-) = 0

Oxidation State of Elements in Polyatomic Ions

TRY IT

Determine the oxidation state of the elements in a polyatomic ion:

Nitrate $(NO_3)^{-1}$ …

Carbonate $(CO_3)^{-2}$ …

Chlorite $(ClO_2)^{-1}$ …

Perphosphate $(PO_5)^{-3}$ …

Oxidation State of Elements in Polyatomic Ions

TRY IT

The sum of the oxidation states of elements in a polyatomic ion equals the charge given:

Oxygen's oxidation is -2 in each case.

Nitrate $(NO_3)^{-1}$ … N + 3(-2) = -1 … therefore, N^{+5}

Carbonate $(CO_3)^{-2}$ … C + 3(-2) = -2 … therefore, C^{+4}

Chlorite $(ClO_2)^{-1}$ … C + 2(-2) = -1 … therefore, Cl^{+3}

Perphosphate $(PO_5)^{-3}$ … P + 5(-2) = -3 … P^{+7}

Name the Covalent Compounds or Give the Formula

NI_3

N_4O

SulfurVI Fluoride

CS_2

Dinitrogen tetroxide

Diphosphorous pentoxide

CarbonII Oxide

H_2O

Name the Covalent Compounds or Give the Formula

NI_3

Nitrogen tri-iodide

N_4O

Tetranitrogen monoxide

SulfurVI Fluoride

$S^{+6}F_6^{-1}$

CS_2

Carbon disulfide

Dinitrogen tetroxide

N_2O_4

Diphosphorous pentoxide

P_2O_5

CarbonII Oxide

CO (carbon monoxide)

H_2O

Dihydrogen monoxide

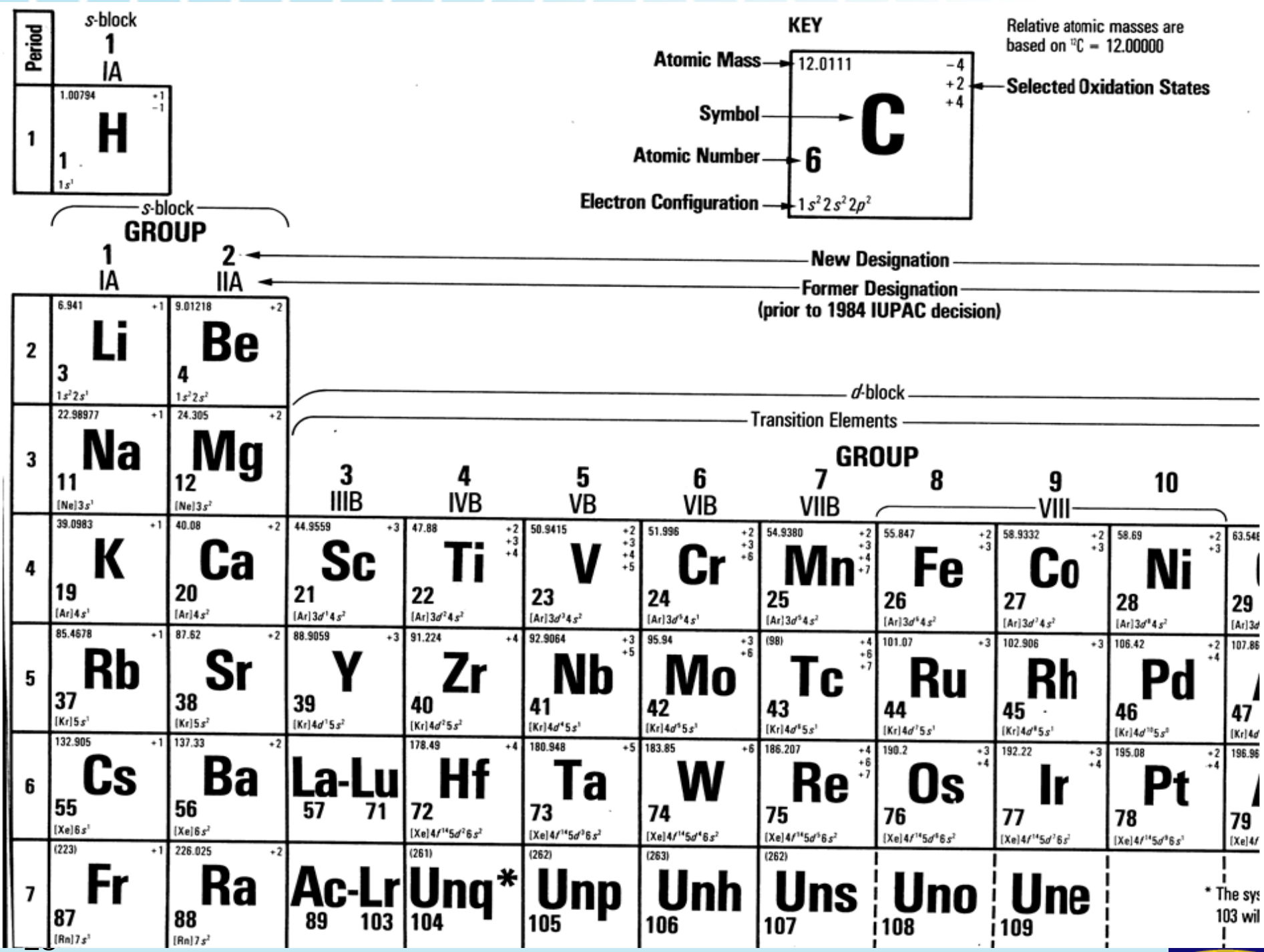
Elements	Formula	Name of Compound
Sodium, Sulfur		
Calcium, Fluorine		
Silver, Oxygen		
Magnesium, Chlorine		
Lithium, Nitrogen		
Strontium, Sulfur		
Barium, Bromine		
Potassium, Oxygen		
Copper (+2), Sulfur		
Copper (+1), Sulfur		
Iron (+2), Oxygen		
Iron (+3) Oxygen		
Aluminum, Chlorine		
Aluminum, Sulfur		
Ammonium, Sulfur		
Copper (+2), Nitrate		
Calcium, Phosphate		
Potassium, Chlorine		
Hydrogen, Oxygen		
Lead (+2), Oxygen		
Sodium, Hydroxide		
Ammonium, Sulfate		
Zinc, Acetate		
Barium, Chlorate		

Elements	Formula	Name of Compound
Sodium, Sulfur	$Na_2^{+1}S^{-2}$	Sodium sulfide
Calcium, Fluorine	$Ca^{+2}F_2^{-1}$	Calcium fluoride
Silver, Oxygen	$Ag_2^{+1}O^{-2}$	Silver oxide
Magnesium, Chlorine	$Mg^{+2}Cl_2^{-1}$	Magnesium chloride
Lithium, Nitrogen	$Li_3^{+1}N^{-3}$	Lithium nitride
Strontium, Sulfur	$Sr^{+2}S^{-2}$	Strontium sulfide
Barium, Bromine	$Ba^{+2}Br_2^{-1}$	Barium bromide
Potassium, Oxygen	$K_2^{+1}O^{-2}$	Potassium oxide
Copper (+2), Sulfur	$Cu^{+2}S^{-2}$	Copper(II) sulfide, cupric sulfide
Copper (+1), Sulfur	$Cu_2^{+1}S^{-2}$	Copper(I) sulfide, cuprous sulfide
Iron (+2), Oxygen	$Fe^{+2}O^{-2}$	Iron(II) oxide, Ferrous Oxide
Iron (+3) Oxygen	$Fe_2^{+3}O_3^{-2}$	Iron(III) oxide, Ferric Oxide
Aluminum, Chlorine	$Al^{+3}Cl_3^{-1}$	Aluminum chloride
Aluminum, Sulfur	$Al_2^{+3}S_3^{-2}$	Aluminum sulfide
Ammonium, Sulfur	$(NH_4)_2^{+1}S^{-2}$	Ammonium sulfide
Copper (+2), Nitrate	$Cu^{+2}(NO_3)_2^{-1}$	Copper(II) nitrate, cupric nitrate
Calcium, Phosphate	$Ca_3^{+2}(PO_4)_2^{-3}$	Calcium phosphate
Potassium, Chlorine	$K^{+1}Cl^{-1}$	Potassium chloride
Hydrogen, Oxygen	$H_2^{+1}O^{-2}$	diHydrogen monoxide, water
Lead (+2), Oxygen	$Pb^{+2}O^{-2}$	Plumbous oxide
Sodium, Hydroxide	$Na^{+1}(OH)^{-1}$	Sodium hydroxide
Ammonium, Sulfate	$(NH_4)_2^{+1}(SO_4)^{-2}$	Ammonium sulfate
Zinc, Acetate	$Zn^{+1}(C_2H_3O_2)_2^{-1}$	Zinc acetate
Barium, Chlorate	$Ba^{+2}(ClO_3)_2^{-1}$	Barium chlorate

TRY IT

General guidelines for writing the name and formula of a chemical compound:

1. Follow the rules for naming acids when **H** is the first element in the formula and it is aqueous (dissolved in water).
2. If the compound is binary, generally the non-metal name ends with the suffix *-ide*.
3. If the compound is a molecular (covalently bonded) binary compound, use prefixes to indicate the number of atoms.
4. When a polyatomic ion that includes oxygen is in the formula, the compound name generally ends in *-ite* or *-ate*.
5. If the compound contains a metallic cation that can have different ionic charges (transition, group B metals), use a Roman numeral to indicate the numerical value of the ionic charge in the compound.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+1
−1
H
1
1s¹
KEY
Atomic Mass
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−4
+2
+4
Selected Oxidation States
Symbol
C
Atomic Number
6
Electron Configuration
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Relative atomic masses are based on ¹²C = 12.00000
s-block
GROUP
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IA
2
IIA
New Designation
Former Designation
(prior to 1984 IUPAC decision)
d-block
Transition Elements
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IIIB
4
IVB
5
VB
6
VIB
7
VIIB
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(262)
Unp
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(263)
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p-block

GROUP

10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 0
								4.00260 0 **He** 2 $1s^2$
			10.81 +3 **B** 5 $1s^2 2s^2 2p^1$	12.0111 −4 +2 +4 **C** 6 $1s^2 2s^2 2p^2$	14.0067 −3 −2 −1 +1 +2 +3 +4 +5 **N** 7 $1s^2 2s^2 2p^3$	15.9994 −2 **O** 8 $1s^2 2s^2 2p^4$	18.998403 −1 **F** 9 $1s^2 2s^2 2p^5$	20.179 0 **Ne** 10 $1s^2 2s^2 2p^6$
			26.98154 +3 **Al** 13 [Ne]$3s^2 3p^1$	28.0855 −4 +2 +4 **Si** 14 [Ne]$3s^2 3p^2$	30.97376 −3 +3 +5 **P** 15 [Ne]$3s^2 3p^3$	32.06 −2 +4 +6 **S** 16 [Ne]$3s^2 3p^4$	35.453 −1 +1 +3 +5 +7 **Cl** 17 [Ne]$3s^2 3p^5$	39.948 0 **Ar** 18 [Ne]$3s^2 3p^6$
58.69 +2 +3 **Ni** 28 [Ar]$3d^8 4s^2$	63.546 +1 +2 **Cu** 29 [Ar]$3d^{10} 4s^1$	65.39 +2 **Zn** 30 [Ar]$3d^{10} 4s^2$	69.72 +3 **Ga** 31 [Ar]$3d^{10} 4s^2 4p^1$	72.59 −4 +2 +4 **Ge** 32 [Ar]$3d^{10} 4s^2 4p^2$	74.9216 −3 +3 +5 **As** 33 [Ar]$3d^{10} 4s^2 4p^3$	78.96 −2 +4 +6 **Se** 34 [Ar]$3d^{10} 4s^2 4p^4$	79.904 −1 +1 +5 **Br** 35 [Ar]$3d^{10} 4s^2 4p^5$	83.80 0 +2 **Kr** 36 [Ar]$3d^{10} 4s^2 4p^6$
106.42 +2 +4 **Pd** 46 [Kr]$4d^{10} 5s^0$	107.868 +1 **Ag** 47 [Kr]$4d^{10} 5s^1$	112.41 +2 **Cd** 48 [Kr]$4d^{10} 5s^2$	114.82 +3 **In** 49 [Kr]$4d^{10} 5s^2 5p^1$	118.71 +2 +4 **Sn** 50 [Kr]$4d^{10} 5s^2 5p^2$	121.75 −3 +3 +5 **Sb** 51 [Kr]$4d^{10} 5s^2 5p^3$	127.60 −2 +4 +6 **Te** 52 [Kr]$4d^{10} 5s^2 5p^4$	126.905 −1 +1 +5 +7 **I** 53 [Kr]$4d^{10} 5s^2 5p^5$	131.29 0 +2 +4 +6 **Xe** 54 [Kr]$4d^{10} 5s^2 5p^6$
195.08 +2 +4 **Pt** 78 [Xe]$4f^{14} 5d^9 6s^1$	196.967 +1 +3 **Au** 79 [Xe]$4f^{14} 5d^{10} 6s^1$	200.59 +1 +2 **Hg** 80 [Xe]$4f^{14} 5d^{10} 6s^2$	204.383 +1 +3 **Tl** 81 [Xe]$4f^{14} 5d^{10} 6s^2 6p^1$	207.2 +2 +4 **Pb** 82 [Xe]$4f^{14} 5d^{10} 6s^2 6p^2$	208.980 +3 +5 **Bi** 83 [Xe]$4f^{14} 5d^{10} 6s^2 6p^3$	(209) +2 +4 **Po** 84 [Xe]$4f^{14} 5d^{10} 6s^2 6p^4$	(210) **At** 85 [Xe]$4f^{14} 5d^{10} 6s^2 6p^5$	(222) 0 **Rn** 86 [Xe]$4f^{14} 5d^{10} 6s^2 6p^6$