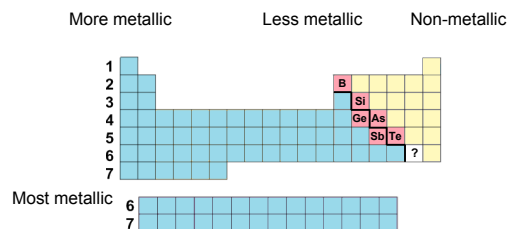




## Metallic Character of the Elements

What the relationship between metallic character and effective nuclear charge? Are they directly or inversely related? Is it accurate to say "Element A is more metallic than element B" even if element B is a non-metal?



## 2 Elements \_\_\_\_\_ exhibit similar physical and chemical properties.

- A with similar chemical symbols
- B with similar atomic masses
- C in the same period of the periodic table
- D on opposite sides of the periodic table
- E in the same group of the periodic table

## 4 Which one of the following is a nonmetal?

- A W
- B Sr
- C Os
- D Ir
- E S

## 1 In the periodic table, the elements are arranged in \_\_\_\_\_.

- A alphabetical order
- B order of increasing atomic number
- C order of increasing metallic properties
- D order of increasing neutron content
- E reverse alphabetical order
- F I don't know how to answer this.

## 3 Which pair of elements would you expect to exhibit the greatest similarity in their physical and chemical properties?

- A Li, Na
- B Cs, Ba
- C Ca, Si
- D Ga, Ge
- E C, O

## 5 Potassium is a \_\_\_\_\_ and chlorine is a \_\_\_\_\_.

- A metal, nonmetal
- B metal, metal
- C metal, metalloid
- D metalloid, nonmetal
- E nonmetal, metal

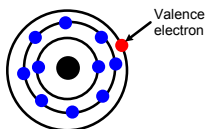
## Valence Electrons and the Octet Rule

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## Valence Electrons

Valence electrons are the electrons in the highest occupied energy level of an element's atoms.

The valence electrons determine the chemical properties of an element. Why do you think this would be true?



To find the number of valence electrons in an atom of a representative element (elements found in the s and p blocks), simply look at its group number.

Atoms in group 3 have 3 valence electrons, atoms in group 17 have 7 valence electrons, etc.

6 How many valence electrons does potassium have?

- A 3
- B 1
- C 19
- D 4
- E 8



## Review: Octet Rule

Atoms tend towards having complete outer shells of electrons (*remember stability*).

A full outer shell will have:

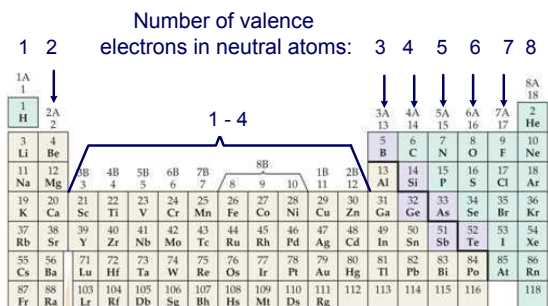
- 2 electrons in the s subshell and
- 6 electrons in the p subshell (*s<sup>2</sup>p<sup>6</sup> configuration*)

Octet rule: atoms tend towards having a total of 8 electrons

8 valence electrons make an octet

Which elements on the periodic table have a complete outer shell? What is true about these elements relative chemical reactivity?

## Valence Electrons



There is one exception:  
helium has only 2 valence electrons.

7 How many valence electrons does Aluminum have?

- A 5
- B 7
- C 3
- D 27
- E 13



8 How many valence electrons does Barium have?

- A 1
- B 2
- C 52
- D 3
- E 6



9 Arsenic (As) has 6 valence electrons.

- True
- False

## Ions

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## Ions

**Ions** are atoms or groups of atoms that have become charged by either *gaining* or *losing* electrons.

**Cations** are positive and are formed by elements on the left side of the periodic chart (metals).

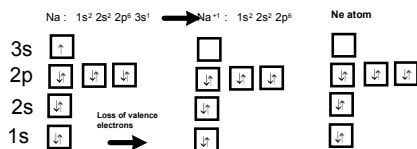
**Anions** are negative and are formed by elements on the right side of the periodic chart (nonmetals).

1A	2A	Transition metals						3A	4A	5A	6A	7A	8A
H <sup>+</sup>	Li <sup>+</sup>							Al <sup>3+</sup>		N <sup>3-</sup>	O <sup>2-</sup>	F <sup>-</sup>	He
Na <sup>+</sup>	Mg <sup>2+</sup>									S <sup>2-</sup>	Cl <sup>-</sup>	Ar	
K <sup>+</sup>	Ca <sup>2+</sup>									Se <sup>2-</sup>	Br <sup>-</sup>	Kr	
Rb <sup>+</sup>	Sr <sup>2+</sup>									Te <sup>2-</sup>	I <sup>-</sup>	Xe	
Cs <sup>+</sup>	Ba <sup>2+</sup>											Rn	

## The Formation of Cations

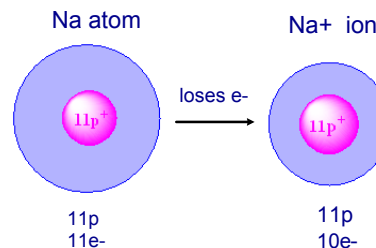
Metals usually give up/lose valence electrons to become more stable.

This often results in a noble gas (8 electron) outer shell.



How many electrons does the Na<sup>+</sup> ion have?

## The Formation of Cations

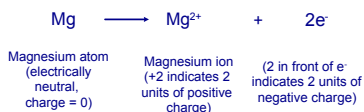


The Na<sup>+</sup> ion is smaller than the Na atom. Do you remember what factors cause this reduction in size?

## The Formation of Cations

Cations of Group 1A elements always have a charge of 1+.

Cations of Group 2A elements always have a charge of 2+.

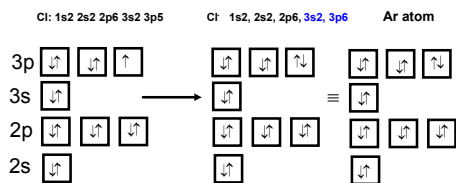


1A	2A
Li <sup>+</sup>	Be <sup>2+</sup>
Na <sup>+</sup>	Mg <sup>2+</sup>
K <sup>+</sup>	Ca <sup>2+</sup>
Rb <sup>+</sup>	Sr <sup>2+</sup>
Cs <sup>+</sup>	Ba <sup>2+</sup>
Fr <sup>+</sup>	Ra <sup>2+</sup>

## The Formation of Anions

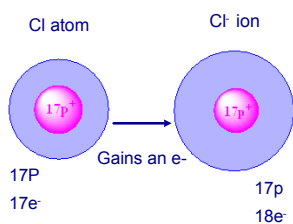
Nonmetals usually gain valence electrons.

This results in a noble gas (8 electrons) outer shell



How many electrons does the Cl<sup>-</sup> have?

## The Formation of Anions



The Cl<sup>-</sup> ion is larger than the Cl atom. Do you remember what factors cause this increase in size?

## The Formation of Anions

Anions of Group 15 (5A) elements always have a charge of 3<sup>-</sup>.

Anions of Group 16 (6A) elements always have a charge of 2<sup>-</sup>.

Anions of Group 17 (7A) elements always have a charge of 1<sup>-</sup>.

Consider Group 14 (4A) elements, what common charge(s) would you predict for these elements?

5A	6A	7A
N <sup>3-</sup>	O <sup>2-</sup>	F <sup>-</sup>
P <sup>3-</sup>	S <sup>2-</sup>	Cl <sup>-</sup>
As <sup>3-</sup>	Se <sup>2-</sup>	Br <sup>-</sup>
Te <sup>2-</sup>	I <sup>-</sup>	

**10** Metals tend to \_\_\_\_\_ electrons and nonmetals tend to \_\_\_\_\_ electrons.

- A gain, gain
- B lose, lose
- C gain, lose
- D lose, gain
- E neither, they keep their electrons

**11** Anions tend to be \_\_\_\_\_ and cations tend to be \_\_\_\_\_.

- A metals, metals
- B nonmetals, nonmetals
- C metals, nonmetals
- D nonmetals, metals
- E metalloids, metalloids

12 Metals lose electrons to form cations

- True
- False

13 Anions are formed from nonmetals

- True
- False

14 Nonmetals tend to lose electrons forming ions

- True
- False

15 This is the ion formed from a calcium atom

- A  $\text{Ca}^+$
- B  $\text{Ca}^{2+}$
- C  $\text{Ca}^-$
- D  $\text{Ca}^{2-}$

16 Phosphorous forms an ion with a charge of \_\_\_\_\_.

- A 1+
- B 2-
- C 3+
- D 3-
- E 2+

17 Aluminum forms an ion with a charge of \_\_\_\_\_.

- A 2+
- B 1-
- C 3+
- D 2-
- E 0

18 Of the following, \_\_\_\_\_ contains the greatest number of electrons.

- A  $P^{3+}$
- B P
- C  $P^{2-}$
- D  $P^{3-}$
- E  $P^{2+}$

20 Iodine forms an ion with a charge of \_\_\_\_\_.

- A 7-
- B 1+
- C 2-
- D 2+
- E 1-

22 Predict the charge of the most stable ion of S?

- A 3+
- B 1-
- C 6+
- D 2+
- E 2-

19 Oxygen forms an ion with a charge of \_\_\_\_\_.

- A 2-
- B 2+
- C 3-
- D 3+
- E 6+

21 This is the ion formed from nitrogen

- A  $N^-$
- B  $N^{2-}$
- C  $N^{3+}$
- D  $N^{3-}$

23

- A +1
- B +2
- C +3
- D +13
- E -5

## Ionic Bonding

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## Ionic Bonding

Electronegativity is **how strongly** an atom **attracts electrons**. Atoms with a high electronegativity will be able to attract electrons away from atoms with a much lower electronegativity.

This removal of electrons can occur when the difference in electronegativity between the two atoms is approximately 1.7 or higher.

Once a positive and negative ion are formed, they will be attracted to each other via the electrostatic force:

$$F = k \frac{q_1 q_2}{r^2}$$

*Note: The heavier nonmetals from 4,6,5th groups (In, Tl, Sn, Pb, Sb Bi) may act like metals*

## Ionic Bonding

Compounds composed of cations and anions are called ionic compounds.

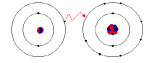
Although they are composed of ions, **ionic compounds are electrically neutral**.

**The electrostatic forces that hold ions together in ionic compounds are called ionic bonds.**

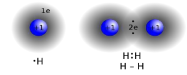
## Introduction to Chemical Bonds

There are three basic types of bonds:

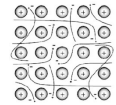
**Ionic** - The electrostatic attraction between ions



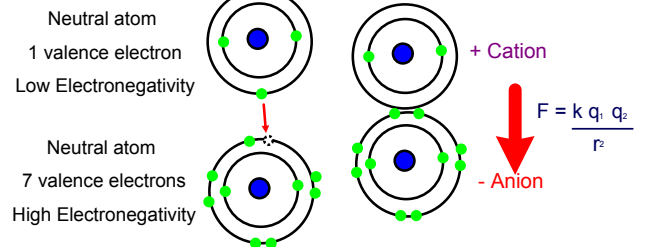
**Covalent** - The sharing of electrons between atoms



**Metallic** - Each metal atom bonds to other metals atoms within a "sea" of electrons (covered in a later unit)



## Ionic Bonding



The atom with high electronegativity attracts valence electrons from the atom with lower electronegativity.

When the atoms become oppositely charged ions the **electrostatic force of attraction** brings them together.

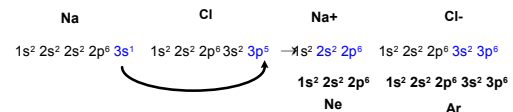
**Electrostatic force of attraction = bond**

## Ionic Bonds

When sodium and chlorine are close together, sodium's valence electron flies off and "harpoons" the chlorine atom.

The result is a sodium cation (+) next to a chloride anion (-)

These oppositely charged two ions attract: they reel one another together to form an ionic bond.





## Ionic Bonds

The electron transfer process in creating an ionic bond:



The dots represents the valence electrons in an atom.

[click here for an animation of this reaction](#)

**27 Which of the following compounds would you expect to be ionic?**

- A H<sub>2</sub>O
- B CO<sub>2</sub>
- C SrCl<sub>2</sub>
- D SO<sub>2</sub>
- E H<sub>2</sub>S

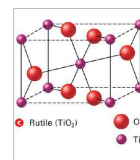
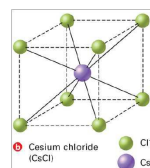
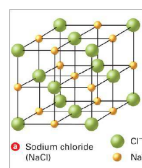
## Properties of Ionic Compounds

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[\*]

## Properties of Ionic Compounds

They are crystalline solids at room temperature  
They have high melting points  
They conduct electricity when melted (molten) or dissolved in water (aqueous)

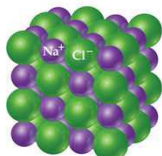


## Formula Units

A chemical formula shows the kinds and numbers of atoms in the smallest representative unit of a substance.

A formula unit is the lowest whole-number ratio of ions in an ionic compound.

Every ionic compound has a 3D array of positive and negative ions.



## Predicting an Ionic Compound's Formula

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### Predicting an Ionic Compound Formula

Potassium (K) with an electronegativity of 0.8 and oxygen (O) with an electronegativity of 3.5 will form an ionic compound.

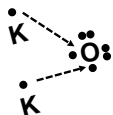
**What is the formula for an ionic compound of potassium and oxygen?**

How many additional valence electrons does oxygen want?

How many valence electrons does potassium have?

How many potassium atoms will it take to give oxygen the electrons it needs?

The formula unit is K<sub>2</sub>O



**Always Metal First (low electronegativity)**

### Predicting an Ionic Compound Formula

**What is the formula for an ionic compound of Mg and N?**

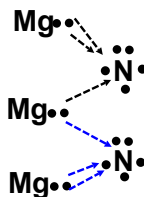
How many additional valence electrons does N want?

How many valence electrons does Mg have to offer?

How many Mg atoms will it take to give how many N the electrons it needs? (*Find the lowest common multiplier first.*)

3 Mg : 2 N

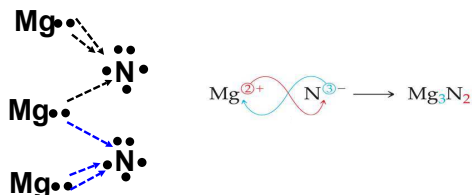
The formula unit is Mg<sub>3</sub>N<sub>2</sub>



### Alternate Method

If you don't like finding least common multipliers, you can use this alternative method:

1. Write down the ions side by side along with their charge. Always write the metal first.
2. "Criss-cross" the numerical values of the charges.
3. Reduce subscripts to lowest ratio.



### Predicting an Ionic Compound Formula

**Example:** Write the formula for calcium sulfide.

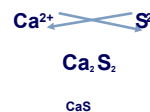
Step 1: Identify the cation & write its common ion

Calcium is in group 2  $\rightarrow$   $\text{Ca}^{2+}$

Step 2: Identify the anion & write its formula

Sulfur is in group 6  $\rightarrow$   $\text{S}^{2-}$

Step 3: Criss-cross; reduce subscripts if necessary



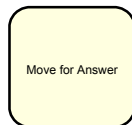
### Predicting an Ionic Compound Formula

What is the compound formed between Mg and S?



The chemical formula would have to be the lowest ratio of ions.

What would you predict would be the formula for this compound?



**28** The formula for the ionic compound between Cs and O is:

- A  $\text{CsO}_2$
- B  $\text{OCs}_2$
- C  $\text{Cs}_2\text{O}$
- D  $\text{OCs}_2$
- E I don't know how to do this.

**29** The ionic compound formed between Ca and N is:

- A  $\text{CaN}$
- B  $\text{Ca}_2\text{N}_2$
- C  $\text{Ca}_3\text{N}_2$
- D  $\text{Ca}_2\text{N}_3$
- E I don't know how to do this.

**30** The ionic compound formed between Al and O

- A  $\text{Al}_3\text{O}_2$
- B  $\text{Al}_2\text{O}_3$
- C  $\text{AlO}$
- D  $\text{Al}_2\text{O}_2$
- E I don't know how to do this.

31 What is the ionic compound formed between Ca and Al?

- A CaAl
- B  $\text{Ca}_3\text{Al}_2$
- C  $\text{Al}_2\text{Ca}_3$
- D No compound is formed.

32 What is the ionic compound formed between P and Br?

- A  $\text{P}_3\text{Br}$
- B BrP
- C This compound is not considered ionic
- D  $(\text{BrP})_2$
- E I don't know how to do this.

33 What is the formula for sodium phosphide?

- A  $\text{SP}_3$
- B NaP
- C  $\text{Na}_3\text{P}$
- D  $\text{NaP}_3$
- E I don't know how to do this.

34 What is the formula for strontium bromide?

- A SrBr
- B  $\text{SrBr}_2$
- C  $\text{Sr}_2\text{Br}$
- D  $\text{BrSr}_2$

35 The formula for barium sulfide is  $\text{Ba}_2\text{S}_2$ .

- True
- False



## Naming Ionic Compounds

## Naming Binary Ionic Compounds - Cations

Many cations have the same name as the original, neutral atom.

Charge	Formula	Name
+1	H <sup>+</sup>	Hydrogen ion
	Li <sup>+</sup>	Lithium ion
	K <sup>+</sup>	Potassium ion
	Cs <sup>+</sup>	Cesium ion
	Ag <sup>+</sup>	Silver ion
+2	Mg <sup>2+</sup>	Magnesium ion
	Ca <sup>2+</sup>	Calcium ion
	Ba <sup>2+</sup>	Barium ion
	Cd <sup>2+</sup>	Cadmium ion
+3	Al <sup>3+</sup>	Aluminum ion

## Naming Binary Ionic Compounds

Binary (two-element) compounds are named by writing the name of the cation followed by the name of the anion.

The name of the cation is the same as the metal name.

The name of the anion is the name of the non-metal with the suffix changed to *-ide*.

Binary ionic compounds end in "*-ide*."

Examples:

NaCl =	Move for Answer
KI =	
Li <sub>2</sub> S =	

37 The correct name for SrO is \_\_\_\_\_.

- A strontium oxide
- B strontium hydroxide
- C strontium peroxide
- D strontium monoxide
- E strontium dioxide

## Naming Binary Ionic Compounds - Anions

All monoatomic anions end in "*-ide*".

The ions that are produced from Group 7A (or 17) elements are called halide ions.

Can you guess the origin of the name halides?

Group 15	Group 16	Group 17
Nitride N <sup>3-</sup>	Oxide O <sup>2-</sup>	Fluoride F <sup>-</sup>
Phosphide P <sup>3-</sup>	Sulfide S <sup>2-</sup>	Chloride Cl <sup>-</sup>
		Bromide Br <sup>-</sup>
		Iodide I <sup>-</sup>

36 The correct name for Na<sub>2</sub>S is

- A Sodium sulfate
- B Sodium sulfide
- C Di-sodium sulfide
- D Sulfur nitride

38 The correct name for Al<sub>2</sub>O<sub>3</sub> is \_\_\_\_\_.

- A aluminum trioxide
- B dialuminum oxide
- C dialuminum trioxide
- D aluminum oxide
- E aluminum hydroxide



## Writing Formulas with Transition Metals

The charge on the cation is indicated by the Roman numeral, as shown in this example.

### Iron (III) oxide

$\text{Fe}^{3+}$     $\text{O}^{2-}$    Write ion formulas.

$\text{Fe}^{3+}$   $\text{O}^{2-}$    Criss-cross charges.

$\text{Fe}_2\text{O}_3$    Reduce if necessary.

## Writing Formulas with Transition Metals

The charge on the cation is indicated by the Roman numeral, as shown in this example.

### Tin (IV) oxide

$\text{Sn}^{4+}$     $\text{O}^{2-}$    Write ion formulas.

$\text{Sn}^{4+}$   $\text{O}^{2-}$    Criss-cross charges.

$\text{Sn}_2\text{O}_4$     $\text{SnO}_2$    Reduce if necessary.

**39 Which metal is capable of forming more than one cation?**

- A K
- B Cs
- C Ba
- D Al
- E Sn

**40 Which metal is not capable of forming more than one cation?**

- A Cu
- B Au
- C Fe
- D Sn
- E Al

## Formulas with Transition Metals

In order to correctly name a formula containing a transition metal, it is necessary to first determine the charge on the cation.

Since all compounds are neutral, then the total positive cation charge must equal the total negative anion charge.

In other words:

$$\text{Total cation charge} + \text{Total anion charge} = 0$$

$$(\text{charge of cation}) (\# \text{ of cations}) + (\text{charge of anion}) (\# \text{ of anions}) = 0$$

## Example Formula with Transition Metals

In the case of  $\text{FeCl}_x$ , we make the following substitutions:

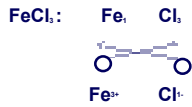
$$(\text{charge of cation}) (\# \text{ of cations}) + (\text{charge of anion}) (\# \text{ of anions}) = 0$$

$$(x) (1) + (-1) (3) = 0$$

Thus  $x = 3$  and the cation is  $\text{Fe}^{3+}$  or iron(III).

### Formulas with Transition Metals

A short cut method is to "uncriss-cross" the ions, but you must always double check your ions (or you'll get in trouble!).



Uncriss-cross.

Check the ions

*Cl does form a 1-ion  
and Fe<sup>3+</sup> is Iron (III)*

**Iron (III) Chloride**

### Formulas with Transition Metals

Here's another practice problem.



Uncriss-cross.

Check the ions

*O forms a 2- ion  
and*

*Cr<sup>3+</sup> does not exist!*

*(this formula had to be reduced from Cr<sub>2</sub>O<sub>2</sub>)*

**Chromium (II) Oxide**

**41 The name of FeCl<sub>3</sub> is**

- A iron chloride
- B iron (II) chloride
- C iron (III) chloride
- D iron(I)chloride

**42**

- A SnO<sub>2</sub>
- B SnO
- C Sn<sub>4</sub>O<sub>4</sub>
- D Sn<sub>4</sub>O<sub>2</sub>
- E SnO<sub>2</sub>

**43 The formula for copper (II) sulfide is**

- A CuS<sub>2</sub>
- B CuS
- C Cu<sub>2</sub> S<sub>2</sub>
- D (CuS)<sub>2</sub>
- E Cu<sub>2</sub>S

**44 Which one of the following compounds is copper(I) chloride?**

- A CuCl
- B CuCl<sub>2</sub>
- C Cu<sub>2</sub>Cl
- D Cu<sub>2</sub>Cl<sub>2</sub>
- E Cu<sub>3</sub>Cl<sub>2</sub>



45 The charge on the cation in the salt  $\text{Fe}_2\text{O}_3$  is \_\_\_\_\_.

- A 1+
- B 2+
- C 3+
- D 5-
- E 6-

47

- True
- False

## Polyatomic Ions

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[\*]

46 What is the charge on zirconium ion in  $\text{ZrO}_2$  ?

- A 2+
- B 4+
- C 1+
- D 2-
- E 3+

48

- A copper nitride
- B copper (I) nitride
- C copper (II) nitride
- D copper(III)nitride
- E copper(III) nitrogen

## Polyatomic Ions

A polyatomic ion is a group of atoms bonded together that have a charge and acts like a single unit or ion.

They are not free compounds and like other ions, are not found free in nature.

They are found combined with other ions.

**Sulfate =  $(\text{SO}_4)^{2-}$**

**Nitrate =  $(\text{NO}_3)^-$**

**Carbonate =  $(\text{CO}_3)^{2-}$**

Use ( ) to keep the atoms together.

*Do not change the subscripts inside the "( )"*

## Polyatomic Ions

Most of the polyatomic ions contain oxygen atoms.

Many anions names end with “-ite” or “-ate”

In “ite/ate” pairs, the ion with fewer oxygen atoms will have the “ite” ending

*Examples: sulfite /sulfate  
nitrite /nitrate*

Note that the suffix does not indicate the actual number of O atoms.

## Polyatomic Ions

Familiarize yourself with the polyatomic ions on your reference sheet  
Be careful of *-ide*, *-ite*, and *-ate*!

H<sup>+</sup> = proton  
or hydrogen ion

Selected Polyatomic Ions		
← H <sub>3</sub> O <sup>+</sup>	hydronium	CrO <sub>4</sub> <sup>2-</sup> chromate
Hg <sub>2</sub> <sup>2+</sup>	dimercury(I)	Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup> dichromate
NH <sub>4</sub> <sup>+</sup>	ammonium	MnO <sub>4</sub> <sup>-</sup> permanganate
C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> <sup>-</sup>	acetate	NO <sub>2</sub> <sup>-</sup> nitrite
CH <sub>3</sub> COO <sup>-</sup>		NO <sub>3</sub> <sup>-</sup> nitrate
CN <sup>-</sup>	cyanide	O <sub>2</sub> <sup>2-</sup> peroxide
CO <sub>3</sub> <sup>2-</sup>	carbonate	OH <sup>-</sup> hydroxide
← HCO <sub>3</sub> <sup>-</sup>	hydrogen carbonate	PO <sub>4</sub> <sup>3-</sup> phosphate
C <sub>2</sub> O <sub>4</sub> <sup>2-</sup>	oxalate	SCN <sup>-</sup> thiocyanate
ClO <sup>-</sup>	hypochlorite	SO <sub>3</sub> <sup>2-</sup> sulfite
ClO <sub>2</sub> <sup>-</sup>	chlorite	SO <sub>4</sub> <sup>2-</sup> sulfate
ClO <sub>3</sub> <sup>-</sup>	chlorate	H <sub>2</sub> SO <sub>4</sub> hydrogen sulfate
ClO <sub>4</sub> <sup>-</sup>	perchlorate	S <sub>2</sub> O <sub>3</sub> <sup>2-</sup> thiosulfate

or bicarbonate

## Formulas and Names of Ionic Compounds with Polyatomic Ions (Ternary Ionic Compounds)

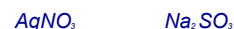
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## Writing Formulas for Ternary Ionic Compounds

Ternary ionic compounds, compounds that contain 3 or more elements, just like binary ionic compounds. Therefore, the goal is to find the lowest ratio of cations to anions that will yield a neutral compound.

This ratio is represented in a **formula unit**.

### Examples of formula units



## Writing Formulas for Ternary Ionic Compounds (con't)

To write a formula, the criss-cross method can again be used.

*Example: Write the formula for lithium phosphate.*

**Step 1: Identify the cation & write its formula**

Lithium is in group 1 --> Li<sup>+</sup>

**Step 2: Identify the anion & write its formula**

Phosphate is a polyatomic ion --> PO<sub>4</sub><sup>3-</sup>

**Step 3: Criss-cross; reduce subscripts if necessary**



## Writing Formulas for Ternary Ionic Compounds

**Example: Write the formula for calcium nitrate.**



When writing formulas with polyatomic ions, there are two important things to remember:

1) It is helpful to use " ( ) " to keep the atoms together, keeping the charge OUTSIDE the ( )

*For example:*



2) NEVER alter any symbols or subscripts INSIDE the " ( ) ". Once finished, if there is no subscript outside of the " ( ) ", remove the " ( ) "

### Writing Formulas for Ternary Ionic Compounds

Example 1: Write the formula for lithium chlorate.

Example 2: Write the formula for manganese(III) carbonate.

Move for Answer

Move for Answer

49 The formula for aluminum phosphate is:

- A  $\text{AlPO}_4$
- B  $\text{Al}_3(\text{PO}_4)$
- C  $\text{Al}_2(\text{PO}_4)_3$
- D  $\text{Al}_3(\text{PO}_4)_3$



50

- A  $\text{Co}_3\text{CO}_3$
- B  $\text{Co}_2\text{CO}_3$
- C  $\text{Co}_2(\text{CO}_3)_3$
- D  $\text{Co}_3(\text{CO}_3)_2$
- E  $\text{CoCO}_3$

51 The formula for sodium hydroxide is

- A  $\text{Na}(\text{OH})_2$
- B  $\text{NaOH}$
- C  $\text{Na}(\text{OH}_2)$
- D  $\text{Na}(\text{HO})$
- E  $\text{NaOH}_2$



52 The formula for calcium sulfate is

- A  $\text{CaSO}_4$
- B  $\text{Ca}_2(\text{SO}_4)_2$
- C  $\text{Ca}(\text{SO}_3)$
- D  $\text{Ca}_2(\text{SO}_3)_2$
- E  $\text{CaS}$



53

- A 1
- B 2
- C 3
- D 4
- E 5

54

- A 1  
 B 2  
 C 3  
 D 4  
 E 5

**PRACTICE****Writing Formulas for Ionic Compounds**

Complete the table by filling in the formula for the ionic compound formed by each pair of cations and anions, as shown for the first pair.

ION	$K^+$	$NH_4^+$	$Mg^{2+}$	$Fe^{3+}$
$Cl^-$	KCl			
$OH^-$				
$CO_3^{2-}$				
$PO_4^{3-}$				

**PRACTICE****Writing Formulas for Ternary Ionic Compounds**

Write the formula for the following compounds:

- Magnesium iodide
- Calcium sulfite
- Barium hydrogen carbonate
- Iron (III) phosphate

Move for  
answer

**Naming Ternary Ionic Compounds**

Ternary ionic compounds contain three or more different elements due to the presence of polyatomic ion(s).

Just as in binary ionic compounds, the name of the cation is given first, followed by the name of the anion.

Names of ternary compounds often end in *-ite* or *-ate*.

Examples

$CaCO_3$ ,  
 $Zn(C_2H_3O_2)_2$ ,  
 $AgNO_3$ ,  
 $Na_2SO_3$

Move for  
answer

**55** The correct name for  $NaClO$  is

- A sodium chlorate  
 B sodium chloride  
 C sodium chlorite  
 D sodium chloride oxide  
 E sodium hypochlorite



**56**  $Mg(HCO_3)_2$  is

- A Magnesium carbonate  
 B Magnesium hydrogen carbonate  
 C Magnesium hydroxide  
 D Magnesium carboxide  
 E Magnesium dibicarbonate

**57 Ammonium carbonate is**

- A  $\text{NH}_4\text{CO}_3$
- B  $(\text{NH}_4)_2\text{CO}_3$
- C  $\text{NH}_4(\text{CO}_3)_2$
- D  $(\text{NH}_4)_2\text{CO}_2$

**58**

- A gallium sulfite
- B gallium (I) sulfite
- C gallium (III) sulfite
- D gallium (III) sulfate

Move for explanation

**60**

- A tin carbonate
- B tin(II) carbonate
- C tin carbide
- D tin tetracarbonate
- E tin (IV) carbonate

**Naming Ternary Ionic Compounds**

If the formula involves a transition or post transition element, you must first deduce the charge so it can be included in the name.

For example: Name  $\text{Cu}_2\text{CO}_3$

1. Un-criss cross the charges.



2. Cu carries a +1 charge

So... this compound is called  
copper(I) carbonate

For example: Name  $\text{Ni}(\text{NO}_3)_2$

Move for answer

**59**

- A gold (I) flouride
- B gold(III) flouride
- C gold flouride
- D gold flourine
- E gold triflouride

Move for explanation

**Polyatomic Patterns**

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### Polyatomic Patterns

Tips for remembering polyatomic ions using patterns: Boron, Carbon, and Nitrogen polyatomic ions have a maximum of 3 oxygens.

Borate	$\text{BO}_3^{3-}$	Borite	$\text{BO}_2^{3-}$
Carbonate	$\text{CO}_3^{2-}$	Carbonite	$\text{CO}_2^{2-}$
Nitrate	$\text{NO}_3^{-1}$	Nitrite	$\text{NO}_2^{-1}$

Charges: -3 -2 -1

\*Lanthanide series

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

\*\*Actinide series

Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No
----	----	----	---	----	----	----	----	----	----	----	----	----	----

### Polyatomic Patterns

Tips for remembering polyatomic ions using patterns: All of the halogens follow the same naming pattern: Per-ate = 4 oxygens, ---ate = 3 oxygens, ---ite = 2 oxygens, --- hypo-ite = 1 oxygen.

Perchlorate	$\text{ClO}_4^{-1}$
Chlorate	$\text{ClO}_3^{-1}$
Chlorite	$\text{ClO}_2^{-1}$
Hypochlorite	$\text{ClO}^{-1}$

Charge: -1

\*Lanthanide series

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

\*\*Actinide series

Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No
----	----	----	---	----	----	----	----	----	----	----	----	----	----

### Polyatomic Patterns

Tips for remembering polyatomic ions using patterns:

Phosphorus and Sulfur polyatomic ions have a maximum of 4 oxygens.

Phosphate	$\text{PO}_4^{3-}$	Phosphite	$\text{PO}_3^{3-}$
Sulfate	$\text{SO}_4^{2-}$	Sulfite	$\text{SO}_3^{2-}$

Charges: -3 -2

\*Lanthanide series

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

\*\*Actinide series

Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No
----	----	----	---	----	----	----	----	----	----	----	----	----	----