
Welcome!

This is a chemistry lesson, covering *how to write the chemical formulas for covalent and ionic compounds*.

I will guide you step-by-step.

I will be asking you many questions along the way.

Each time I ask a question, **you should attempt to answer the question on your own** before you scroll down to view my answer.

TABLE OF CONTENTS FOR THE LESSON

This is a lesson in the chapter "Atoms, Molecules, and Compounds",
which is part of the series "Chemistry, Explained Step by Step".

This lesson builds on the material covered in the previous lessons:

Ions,

Ionic Compounds and Covalent Compounds,

Distinguishing Ionic and Covalent Compounds, and

Naming Covalent and Ionic Compounds

You should complete those lessons before attempting this lesson.

This lesson was written by Freelance-Teacher.

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Let's begin.

In the previous lesson, we learned how to write the name of a compound, when given the chemical formula:

chemical formula -> name

In this lesson, we will learn how to write the chemical formula for a compound, when given the name:

name -> chemical formula

Here are three rules for writing the formula of a binary *covalent* compound.

1. The elements appear *in the same order* in the chemical formula as in the name.

2. For a covalent compound, the Greek prefixes in the name of the compound will tell you what subscripts to write in the formula.

3. For a covalent compound, if the first element in the name does not have a Greek prefix, that indicates that each molecule of the compound contains *one* atom of that element.

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1. What are the first six Greek prefixes used for naming covalent compounds?

We learned these prefixes in the previous lesson.

Number of atoms of the element	Prefix	Usage
1 atom	mono-	used for the second element in the name only
2 atoms	di-	used for either the first or second element in the name
3 atoms	tri-	used for either the first or second element
4 atoms	tetra-	used for either the first or second element
5 atoms	penta-	used for either the first or second element
6 atoms	hexa-	used for either the first or second element

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2. What is the chemical formula for the compound dinitrogen tetrachloride?

Answer: the formula for dinitrogen tetrachloride is N_2Cl_4.

Analysis:

The first step is to check whether dinitrogen tetrachloride is an ionic compound or a covalent compound.

Dinitrogen tetrachloride contains
two nonmetals (nitrogen and chlorine).

So dinitrogen tetrachloride is a covalent compound.

So we follow the rules for binary covalent compounds.

The correct formula for dinitrogen tetrachloride is N_2Cl_4.

Notice that:

The elements appear in the same order in the chemical formula as in the name.

For a *covalent* compound, the Greek prefixes from the name of the compound tell us the subscripts
for the chemical formula.

The prefix di- tells us that the subscript for nitrogen is 2, and
the prefix tetra- tells us that the subscript for chlorine is 4.

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3. What is the chemical formula for iodine trichloride?

Answer: the formula for iodine trichloride is ICl_3

Analysis:

The first step is to check whether iodine trichloride is an ionic compound or a covalent compound.

Iodine trichloride contains
two nonmetals (iodine and chlorine),
so iodine trichloride is a covalent compound.

The correct formula for iodine trichloride is ICl_3.

Notice that:

The elements appear in the same order in the chemical formula as in the name.

For a *covalent* compound, the Greek prefixes from the name of the compound tell us the subscripts for the chemical formula.

The prefix mono- is generally omitted for the first element in the name,
so the name iodine trichloride indicates the presence of *one* iodine and three chlorines.

It is conventional to omit the subscript $_1$ from a chemical formula,
so the conventional formula is ICl_3, not I_1Cl_3.

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4. What is the chemical formula for the compound dichlorine monoxide?

Answer: the formula for dichlorine monoxide is Cl_2O.

Analysis:

The first step is to check whether dichlorine monoxide is an ionic compound or a covalent compound.

Dichlorine monoxide contains
two nonmetals (chlorine and oxygen).

So dichlorine monoxide is a covalent compound.

So we follow the rules for binary covalent compounds.

The correct formula for dichlorine monoxide is Cl_2O.

Notice that:

The elements appear in the same order in the chemical formula as in the name.

For a *covalent* compound, the Greek prefixes from the name of the compound tell us the subscripts for the chemical formula.

It is conventional to omit the subscript $_1$ from a chemical formula,
so the conventional formula is Cl_2O, not Cl_2O_1.

We have learned how to write the formula for a *covalent* compound.

Our next job is to learn how to write the formula for an *ionic* compound.

We'll begin this topic by reviewing some material from previous lessons that we'll need for this lesson.

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5. What charge is an aluminum ion likely to take?

Answer:

Aluminum (Al) is likely to take a +3 charge.

Analysis:

We learned how to solve this type of problem in the lesson on Ions.

In that lesson, we learned that, in order to achieve a favorable electron configuration,
a neutral atom would like to either gain or lose electrons,
in order to achieve the same number of electrons as the "nearest" noble gas in the periodic table.

In the periodic table, the *nearest* noble gas to aluminum (Al) is *neon*.

(Aluminum is three steps from neon, and aluminum is five steps from argon.)

In the table, neon is three steps to the *left* of aluminum.

(Imagine that, when we "step" leftward from the leftmost column of the table,
we "wrap around" and end up in the rightmost column of the table.)

Therefore, in order to achieve the same electron configuration as neon,
aluminum will need to *lose* three electrons.

So aluminum is likely to lose three electrons.

Gaining an electron would make an atom one step more negative,
so losing an electron will make an atom one step more positive.

Assume the aluminum began with zero charge.

The aluminum loses three electrons, so the aluminum becomes three steps more positive.

So, after *losing* three electrons,
aluminum is likely to form a +3 ion.

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6. What charge is an oxygen ion likely to take?

Answer:

Oxygen (O) is likely to take a -2 charge.

Analysis:

Consider a neutral oxygen atom.

A neutral atom tends to gain or lose electrons
in order to achieve the same number of electrons as the "nearest" noble gas in the periodic table.

In the periodic table, the *nearest* noble gas to oxygen (O) is *neon*.

Neon is two steps to the *right* of oxygen.

Therefore, to reach neon's electron configuration,
oxygen will need to *gain* 2 electrons.

Gaining an electron will make an atom one step more negative.

Assume the oxygen began with zero charge.

The oxygen gains two electrons, so the oxygen becomes two steps more negative.

Therefore, after *gaining* two electrons,
oxygen is likely to form a -2 ion.

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7. What is the structure of carbon tetrachloride (CCl_4)?

CCl_4 consists of two nonmetals (carbon and chlorine),
so carbon tetrachloride is a *covalent* compound.

We studied the structure of covalent compounds in the lesson on Ionic and Covalent Compounds.

As a covalent compound,
carbon tetrachloride consists of many, many, many *separate* CCl_4 molecules.

As is indicated by the chemical formula (CCl_4),
each molecule consists of one carbon atom and four chlorine atoms.

Each molecule is held together by covalent bonds between the atoms.

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8. What is the structure of table salt (NaCl)?

NaCl contains a metal (Na) and a nonmetal (Cl),
so NaCl is an *ionic* compound.

We studied the structure of ionic compounds in the lesson on Ionic and Covalent Compounds.

As an ionic compound,
NaCl consists of a *continuous*, solid, three-dimensional array
of many, many, many Na^+ cations and Cl^- anions.

As is indicated by the chemical formula (NaCl),
the cations and anions appear in the array in a 1:1 ratio
(i.e., the same number of Na^+ cations and of Cl^- anions).

The array is held together by attractions between the anions and the cations.

Now let's introduce a new concept.

When discussing *ionic* compounds,
it is convenient to use the concept of a *formula unit*.

Here are some examples of formula units for ionic compounds:

For NaCl, one formula unit consists of one Na^+ cation and one Cl^- anion.

For Al_2O_3, one formula unit consists of two Al^{3+} cations and three O^{2-} anions.

For $CaCl_2$, one formula unit consists of one Ca^{2+} cation and two Cl^- anions.

You can see from these examples that
when a subscript is omitted in a chemical formula,
that subscript is interpreted as a $_1$

The concept of a *formula unit* is applied only to an *ionic* compound,
not to a covalent compound.

The concept of a *molecule* is applied only to a *covalent* compound,
not to an ionic compound.

What's the difference between a formula unit and a molecule?

A covalent compound consists of *separate* molecules.

In contrast, there are no separate formula units within the structure of an ionic compound.

Rather, an ionic compound is a *continuous* array of cations and anions.

Click this link for a picture of the structure of the ionic compound NaCl:
https://simple.wikipedia.org/wiki/Ionic_compound#/media/File:Sodium-chloride-3D-ionic.png

From the picture you can see that the structure of NaCl is a *continuous* array of Na^+ cations and Cl^- anions;

you will observe from this picture that no *separate* formula units can be identified in the structure of the ionic compound.

If no separate formula units can be identified in the structure of an ionic compound,
then how is the concept of a formula unit going to be useful when working with ionic compounds?

Well, it turns out the concept of a formula unit can provide a useful terminology for *discussing* an ionic compound,
even though there are no separate formula units within the structure of the ionic compound.

We will see how the term "formula unit" can be useful for discussing an ionic compound, on the next page of this lesson.

We will be using the concept of "net charge".

The word "net" means:

add up all the values,
being careful to include a negative sign in front of negative values.

So "net charge" means:

add up all the charges,
being careful to include a negative sign in front of negative charges.

All ionic compounds have a net charge of *zero*.

This implies that, in any ionic compound,
each formula unit will also have a net charge of zero.

For example:

9. Confirm that the net charge for $AlBr_3$ (aluminum bromide) is zero.

Use the following notation:

Write the chemical formula, $AlBr_3$.

For the sake of clarity, let's write the Al with an explicit subscript of $_1$

Then, below the atomic symbols in the formula,
we write that the *individual* charge on each individual aluminum ion is +3,
and that the *individual* charge on each individual bromide ion is -1:

group charges		
	Al_1	Br_3
individual charges	+3	-1

Now, above the atomic symbols in the formula, we write the group charges.

A single formula unit of $AlBr_3$ contains three bromide ions, each with a -1 charge;
so the total charge for the *group* of three bromide ions is 3(-1) = -3.

A single formula unit of $AlBr_3$ contains one aluminum ion, with a +3 charge;
so the total charge for the "group" of one aluminum ion is 1(+3) = +3.

Write these group charges *above* the atomic symbols in the formula.

Our completed notation now looks like this:

group charges	+3	-3
	Al_1	Br_3
individual charges	+3	-1

We can now calculate that

net charge for one formula unit = +3 + (-3)

So: net charge for one formula unit = 0

It should be obvious that if each formula unit has a net charge of zero,
then the compound as a whole must also have a net charge of zero.

Thus, we have confirmed that the net charge for the ionic compound $AlBr_3$ is zero.

That's what we expect: the net charge for all ionic compounds is zero.

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10. Confirm that the net charge for Na_2S (sodium sulfide) is zero.
Use the same notation for keeping track of individual and group charges that we introduced in the previous problem.

We write the chemical formula Na_2S.

For clarity, let's write the symbol S with an explicit subscript of $_1$

Then, below the atomic symbols in the formula,
we write that the *individual* charge on each individual sodium ion is +1,
and that the *individual* charge on the sulfide ion is -2:

group charges		
	Na_2	S_1
individual charges	+1	-2

Now, calculate the group charges.

Each formula unit of Na_2S contains two sodium ions, each with a +1 charge;
so the total charge for the group of two sodium ions is 2(+1) = +2.

Each formula unit of Na_2S contains one sulfide ion, with a -2 charge;
so the total charge for the "group" of one sulfide ion is 1(-2) = -2.

Write these group charges *above* the atomic symbols in the formula.

Our completed notation now looks like this:

group charges	+2	-2
	Na_2	S_1
individual charges	+1	-2

We can now calculate that

net charge for one formula unit = +2 + (-2)

So: net charge for one formula unit = 0

It should be obvious that if each formula unit has a net charge of zero,
then the compound as a whole must also have a net charge of zero.

Thus, we have confirmed that the net charge for the ionic compound Na_2S is zero.

That's what we expect: the net charge for all ionic compounds is zero.

I think you will find this notation for keeping track of "individual" and "group" charges to be helpful at a number of points in your chemistry course.

We are ready now to work on problems in which you have to write the formula for an *ionic* compound, when given the name.

The first rule is:

The elements appear in the same order in the chemical formula as in the name.

This rule works for both binary ionic compounds and binary covalent compounds.

Now, we have seen that, when writing the formula for a *covalent* compound,
the subscripts will already be indicated by the Greek prefixes in the name.

But the names of *ionic* compounds do not include Greek prefixes.

Therefore, when writing the formula for an *ionic* compound, it is *your* job to figure out the subscripts.

When writing the formula for an *ionic* compound, it is *your* job to figure out the subscripts.

How do you do this?

The key is that, when given the name of an ionic compound,
you should choose subscripts for the chemical formula
that will result in a net charge of zero for the compound.

To be more precise, for an ionic compound,
you should choose the *smallest possible* subscripts
that result in a net charge of zero.

For example:

11. What is the chemical formula for lithium nitride?

Answer:

The chemical formula for lithium nitride is Li_3N.

Analysis:

First, we check whether we are dealing with an ionic or a covalent compound.

Lithium is a metal, and nitrogen is a nonmetal,
so we know that lithium nitride is an ionic compound.

When writing the formula for a covalent compound, the subscripts are already indicated in the name; but, when writing the formula for an *ionic* compound, it is *your* job to figure out the subscripts.

Lithium nitride is an ionic compound,
so it is *our job* to figure out the subscripts.

Let's set up the following notation.

We will leave the subscripts blank
to indicate that so far the subscripts for the formula are unknown.

We identify that the charge on each individual lithium cation is +1,
and the charge on each individual nitride anion is -3.

group charges		
	Li	N
individual charges	+1	-3

Notice that lithium appears first in the name of the compound ("lithium nitride"), so Li is listed first in the chemical formula;

nitrogen ("nitride") appears second in the name, so N is listed second in the chemical formula.

So far, the subscripts for our chemical formula are unknown.

But we know that all ionic compounds have a net charge of zero.

So *we have to choose subscripts that will result in a compound with a net charge of zero*.

You can discover the correct subscripts by "guessing-and-checking".

Let's *guess* that the correct subscripts
are $_3$ for the lithium ion and $_1$ for the nitride ion.

Record your guesses for the subscripts in your notation:

group charges		
	Li_3	N_1
individual charges	+1	-3

Now we need to *check* whether those subscripts result in a net charge of zero.

Let's determine what the group charges *would be*,
if the subscripts were $_3$ and $_1$.

According to our guess,
one formula unit of lithium nitride would contain three lithium ions, each with a +1 charge,
so the entire group of three lithium ions would have a charge of 3(+1) = +3;

and one formula unit of lithium nitride would contain one nitrogen ion, with a -3 charge,
so the "group" of one nitrogen ion would have a charge of 1(-3) = -3.

Record these group charges *above* the atomic symbols in the formula.

group charges	+3	-3
	Li_3	N_1
individual charges	+1	-3

Now check the net charge.

net charge = +3 + (-3)

So: net charge = 0.

We have confirmed that,
if the subscripts *were* $_3$ for the lithium and $_1$ for the nitride,
the net charge *would be* zero.

That was the outcome we were hoping for.

So we conclude that $_3$ and $_1$ are the *correct* subscripts.

If we had guessed the wrong subscripts
(say, $_1$ for the lithium and $_3$ for the nitride),
we would have discovered that those subscripts would *not* result in a net charge of zero for the compound;
this would have told us that we needed to *reject* our first guess for the subscripts
and then come up with another guess for the subscripts.

The convention is that subscripts of $_1$ are omitted from chemical formulas,
so our final answer is that the chemical formula for lithium nitride is Li_3N.

We will work on more examples on the next page.

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12. What is the chemical formula for calcium iodide?

Answer:

The chemical formula for calcium iodide is CaI_2.

Analysis:

First, check whether you're dealing with an ionic or a covalent compound.

Calcium iodide consists of a metal (Ca) and a nonmetal (I), so calcium iodide is an ionic compound.

When writing the formula for an *ionic* compound, it is *your* job to figure out the subscripts.

Set up the following notation.

To begin with we leave the subscripts blank,
which indicates that so far the subscripts for the formula are unknown.

The charge on each individual calcium cation is +2, and
the charge on each individual iodide anion is -1.

group charges		
	Ca	I
individual charges	+2	-1

All ionic compounds have a net charge of zero.

So *we have to choose subscripts that will result in a compound with a net charge of zero*.

You can discover the correct subscripts by "guessing-and-checking".

Let's *guess* that the correct subscripts
are $_1$ for the calcium ion and $_2$ for the iodide ion:

group charges		
	Ca_1	I_2
individual charges	+2	-1

Now we need to *check* whether those subscripts result in a net charge of zero.

Based on our guess for the subscripts,
one formula unit of calcium iodide would contain one calcium ion with a +2 charge,
so the "group" of one calcium ion would have a charge of 1(+2) = +2;

and one formula unit of calcium iodide would contain two iodide ions, each with a -1 charge,
so the entire group of two iodide ions would have a charge of 2(-1) = -2.

group charges	+2	-2
	Ca_1	I_2
individual charges	+2	-1

So: net charge = +2 + (-2)

So: net charge = 0.

We have confirmed that,
if the subscripts *were* $_1$ for calcium and $_2$ for iodide,
the net charge *would be* zero.

That was the outcome we were hoping for.

So we conclude that $_1$ and $_2$ are the *correct* subscripts.

The convention is that subscripts of $_1$ are omitted from chemical formulas,
so our final answer is that the chemical formula for calcium iodide is CaI_2.

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13. What is the chemical formula for aluminum oxide?

Answer:

The chemical formula for aluminum oxide is Al_2O_3.

Analysis:

First, check whether you're dealing with an ionic or a covalent compound.

Aluminum oxide consists of a metal (Al) and a nonmetal (O), so aluminum oxide is an ionic compound.

Because this is an *ionic* compound, it will be *our job* to figure out the subscripts.

The charge on each individual aluminum cation is +3, and
the charge on each individual oxide anion is -2.

group charges		
	Al	O
individual charges	+3	-2

Now, *we have to choose subscripts that will result in a compound with a net charge of zero*.

Let's *guess* that the correct subscripts
are $_2$ for the aluminum ion and $_3$ for the oxide ion.

group charges		
	Al_2	O_3
individual charges	+3	-2

Now we need to *check* whether those subscripts result in a net charge of zero.

Based on our guess for the subscripts,
one formula unit of aluminum oxide would contain two aluminum ions, each with a +3 charge,
so the "group" of two aluminum ions would have a charge of 2(+3) = +6;

and one formula unit of aluminum oxide would contain three oxide ions, each with a -2 charge,
so the entire group of three oxide ions would have a charge of 3(-2) = -6.

group charges	+6	-6
	Al_2	O_3
individual charges	+3	-2

So: net charge = +6 + (-6)

So: net charge = 0.

We have confirmed that,
if the subscripts *were* $_2$ for aluminum and $_3$ for oxide,
the net charge *would be* zero.

That was the outcome we were hoping for.

So we conclude that $_2$ and $_3$ are the *correct* subscripts.

Our final answer is that the chemical formula for aluminum oxide is Al_2O_3.

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14. What is the chemical formula for barium sulfide?

Answer:

The chemical formula for barium sulfide is BaS.

Analysis:

This is an easy one, but we will present a systematic solution nevertheless!

First, check whether you're dealing with an ionic or a covalent compound.

Barium sulfide consists of a metal (Ba) and a nonmetal (S), so barium sulfide is an ionic compound; so it will be *our job* to figure out the subscripts for the formula.

The charge on each individual barium cation is +2, and
the charge on each individual sulfide anion is -2:

group charges		
	Ba	S
individual charges	+2	-2

Now, we have to choose subscripts that will result in a compound with a *net charge of zero*.

It's pretty obvious how to do that in this case!

Let's "guess" that the correct subscripts
are $_1$ for the barium ion and $_1$ for the sulfide ion.

Based on these subscripts,
one formula unit of barium sulfide would contain one barium ion, with a +2 charge,
so the "group" of one barium ion would have a charge of 1(+2) = +2;

and one formula unit of barium sulfide would contain one sulfide ion, with a -2 charge,
so the "group" of one sulfide ion would have a charge of 1(-2) = -2.

group charges	+2	-2
	Ba_1	S_1
individual charges	+2	-2

So: net charge = +2 + (-2)

So: net charge = 0.

That was the outcome we were hoping for.

So $_1$ and $_1$ are the *correct* subscripts.

Our final answer is that the chemical formula for barium sulfide is BaS.

When writing the formula for an ionic compound,
you should choose the *smallest possible* subscripts
that result in a net charge of zero.

For example, for lithium nitride,
don't write Li_6N_2;
instead, write Li_3N.

For calcium iodide,
don't write Ca_2I_4;
instead, write CaI_2.

For aluminum oxide,
don't write Al_4O_6;
instead, write Al_2O_3.

For barium sulfide,
don't write Ba_2S_2;
instead, write BaS.

Let's do some integrated practice, integrating all the problem types we've seen in this lesson and the previous lesson.

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15. What is the chemical formula for cesium oxide?

Answer:

The chemical formula for cesium oxide is Cs_2O.

Analysis:

First, check whether you're dealing with an ionic or a covalent compound.

Cesium oxide consists of a metal (Cs) and a nonmetal (O), so cesium oxide is an ionic compound.

Because this is an *ionic* compound, it will be *our job* to figure out the subscripts.

The charge on each individual cesium cation is +1, and
the charge on each individual oxide anion is -2.

group charges		
	Cs	O
individual charges	+1	-2

Now, *we have to choose subscripts that will result in a compound with a net charge of zero*.

Let's *guess* that the correct subscripts
are $_2$ for the cesium ion and $_1$ for the oxide ion.

group charges		
	Cs_2	O_1
individual charges	+1	-2

Now we need to *check* whether those subscripts result in a net charge of zero.

Based on our guess for the subscripts,
one formula unit of cesium oxide would contain two cesium ions, each with a +1 charge,
so the "group" of two cesium ions would have a charge of 2(+1) = +2;

and one formula unit of cesium oxide would contain one oxide ion with a -2 charge,
so the entire group of one oxide ion would have a charge of 1(-2) = -2.

group charges	+2	-2
	Cs_2	O_1
individual charges	+1	-2

So: net charge = +2 + (-2)

So: net charge = 0.

We have confirmed that,
if the subscripts *were* $_2$ for cesium and $_1$ for oxide,
the net charge *would be* zero.

That was the outcome we were hoping for.

So we conclude that $_2$ and $_1$ are the *correct* subscripts.

It is conventional to omit the subscript $_1$ from a chemical formula,
so the conventional formula is Cs_2O, not Cs_2O_1.

----

16. What is the chemical formula for magnesium nitride?

Answer:

The chemical formula for magnesium nitride is Mg_3N_2.

Analysis:

First, check whether you're dealing with an ionic or a covalent compound.

Magnesium nitride consists of a metal (Mg) and a nonmetal (N), so magnesium nitride is an ionic compound.

Because this is an *ionic* compound, it will be *our job* to figure out the subscripts.

The charge on each individual magnesium cation is +2, and
the charge on each individual nitride anion is -3.

group charges		
	Mg	N
individual charges	+2	-3

Now, *we have to choose subscripts that will result in a compound with a net charge of zero*.

Let's *guess* that the correct subscripts
are $_3$ for the magnesium ion and $_2$ for the nitride ion.

group charges		
	Mg_3	N_2
individual charges	+2	-3

Now we need to *check* whether those subscripts result in a net charge of zero.

Based on our guess for the subscripts,
one formula unit of magnesium nitride would contain three magnesium ions, each with a +2 charge,
so the "group" of three magnesium ions would have a charge of 3(+2) = +6;

and one formula unit of magnesium nitride would contain two nitride ions, each with a -3 charge,
so the entire group of two nitride ions would have a charge of 2(-3) = -6.

group charges	+6	-6
	Mg_3	N_2
individual charges	+2	-3

So: net charge = +6 + (-6)

So: net charge = 0.

We have confirmed that,
if the subscripts *were* $_3$ for magnesium and $_2$ for nitride,
the net charge *would be* zero.

That was the outcome we were hoping for.

So we conclude that $_3$ and $_2$ are the *correct* subscripts.

Our final answer is that the chemical formula for magnesium nitride is Mg_3N_2.

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17. What is the chemical formula for the compound tetraphosphorus hexoxide?

Answer: the formula for tetraphosphorus hexoxide is P_4O_6.

Analysis:

The first step is to check whether tetraphosphorus hexoxide is an ionic compound or a covalent compound.

Tetraphosphorus hexoxide contains
two nonmetals (phosphorus and oxygen).

So tetraphosphorus hexoxide is a covalent compound.

So we follow the rules for binary covalent compounds.

The correct formula for tetraphosphorus hexoxide is P_4O_6.

Notice that:

The elements appear in the same order in the chemical formula as in the name.

For a *covalent* compound, the Greek prefixes from the name of the compound tell us the subscripts for the chemical formula.

----

18. What is the chemical formula for the compound carbon disulfide?

Answer: the formula for carbon disulfide is CS_2.

Analysis:

The first step is to check whether carbon disulfide is an ionic compound or a covalent compound.

Carbon disulfide contains
two nonmetals (carbon and sulfur).

So carbon disulfide is a covalent compound.

So we follow the rules for binary covalent compounds.

The correct formula for carbon disulfide is CS_2.

Notice that:

The elements appear in the same order in the chemical formula as in the name.

For a *covalent* compound, the Greek prefixes from the name of the compound tell us the subscripts for the chemical formula.

The prefix mono- is usually omitted for the first element,
so carbon disulfide means CS_2, not C_2S_2.

It is conventional to omit the subscript $_1$ from a chemical formula,
so the conventional formula is CS_2, not C_1S_2.

----

19. What is the name of the compound represented by the chemical formula SO_3?

Answer: the name of SO_3 is *sulfur trioxide*

Analysis:

First, we must check whether SO_3 is an ionic compound or a covalent compound.

SO_3 contains
two nonmetals (sulfur and oxygen)
so SO_3 is a covalent compound.

We learned to name a covalent compound in the lesson on Naming Covalent and Ionic Compounds.

The name of SO_3 is *sulfur trioxide*.

Notice that:

The elements appear in the same order in the name as in the chemical formula.

Sulfur appears first in both the name and the formula.

Oxygen appears second in the name, with the suffix -ide.

The formula contains one sulfur and three oxygens,
but the prefix mono- is omitted for the *first* element in the name,
so we use only the prefix tri-.

----

20. What is the name of the compound represented by the formula CaF_2?

Answer:

The name of CaF_2 is *calcium fluoride*.

Analysis:

The first step is to identify whether CaF_2 is an ionic compound or a covalent compound.

CaF_2 consists of both a metal (Ca) and a nonmetal (F), so CaF_2 is an ionic compound.

We learned to name an ionic compound in the lesson on Naming Covalent and Ionic Compounds.

The ionic compound CaF_2 consists of:
Ca^{2+} cations, and
F^- anions

So we apply the rules we have learned for naming ionic compounds.

The name of the compound is *calcium fluoride*.

Notice that:

The name of the cation (calcium ion) appears first, but without the word "ion".

The name of the anion (fluoride ion) appears second, but without the word "ion".

The name of the monatomic cation (calcium) is the same as the name of the neutral element.

The name of the monatomic anion (fluoride) ends with the suffix -ide.

The implied subscript $_1$ and the written subscript $_2$ from the formula do not affect the name of the ionic compound.

Let's review what we've learned in this lesson.

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21. How do you know what order to write the elements in the chemical formula for a covalent compound?
How do you know what order to write the elements in the chemical formula for an ionic compound?

For a binary compound, the elements appear *in the same order* in the chemical formula as in the name.

This rule works for both binary ionic compounds and binary covalent compounds.

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22. Fill in the blank.
One formula unit of AlF_3 consists of ____________________.

One formula unit of AlF_3 consists of *one Al^{3+} cation and three F^- anions*.

---

23. Compare and contrast the concept of a molecule with the concept of a formula unit.

The concept of a *formula unit* is applied only to an *ionic* compound,
not to a covalent compound.

The concept of a *molecule* is applied only to a *covalent* compound,
not to an ionic compound.

A covalent compound consists of *separate* molecules.

In contrast, there are no separate formula units within the structure of an ionic compound.

Rather, an ionic compound is a *continuous* array of cations and anions.

We have seen in this lesson that the term "formula unit" can be useful when *discussing* an ionic compound,
even though there are no separate formula units within the structure of an ionic compound.

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24. What is the net charge for an ionic compound?

The net charge for any ionic compound is *zero*.

The net charge for *ions* is positive or negative.

For example, the net charge for SO_4^{2-} is -2;
and the net charge for NH_4^+ is +1.

But the net charge for an ionic *compound* must be zero.

This implies that the net charge for one formula unit of an ionic compound must also be zero.

---

25. What is the key difference between writing the formula for an ionic compound and writing the formula for a covalent compound?

When writing the formula for a *covalent* compound, the subscripts will already be indicated by the Greek prefixes in the name.

But, when writing the formula for an *ionic* compound, it is *your* job to figure out the subscripts.

---

26. How can I figure out the subscripts for the chemical formula for an ionic compound?

Choose the smallest possible subscripts that will give the ionic compound a *net charge of zero*.

You can do this by choosing the smallest possible subscripts that will give each formula unit of the compound a net charge of zero.

---

27. How can I figure out the subscripts for the chemical formula for a covalent compound?

There's no need to "figure them out";
for a covalent compound, the Greek prefixes in the name of the compound will *tell* you the subscripts.

(You do need to remember that, for a covalent compound, if the first element in the name has no prefix, that means that one molecule of the compound contains one atom of that element.)

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28. True or false? Explain why the statement is true or false.
The chemical formula for lithium oxide is LiO.

False.

Lithium oxide is an ionic compound.

When writing the formula for an ionic compound,
it is *your job* to determine the correct subscripts.

Oxide anion has a -2 charge (O^{2-}).

Lithium cation has a +1 charge (Li^+).

So, to balance the O^{2-} anion,
one formula unit needs *two* Li^+ cations.

So the correct chemical formula for lithium oxide is Li_2O.

You have reached the end of the lesson.

You're ready now to proceed to the next lesson:

Writing Chemical Formulas for Ionic Compounds with Transition Metals