



Compounds

Section 3.1

3.1 Compounds

- Compounds are pure substances made of more than one kind of atom joined together. The atoms are held together with chemical bonds.
- Compounds come in two basic types: covalent and ionic.

In ionic compounds, atoms gain or lose electrons to form ions.

Example: NaCl

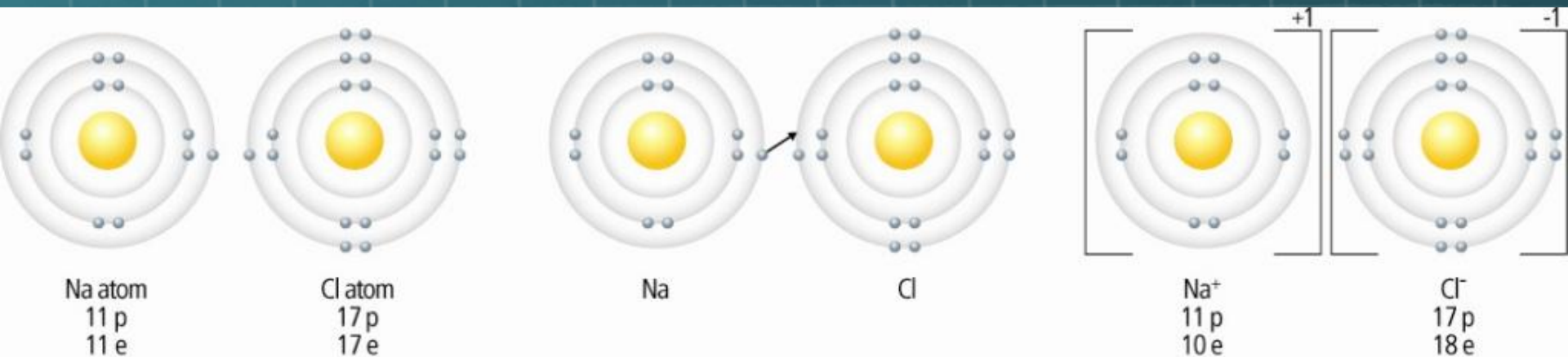


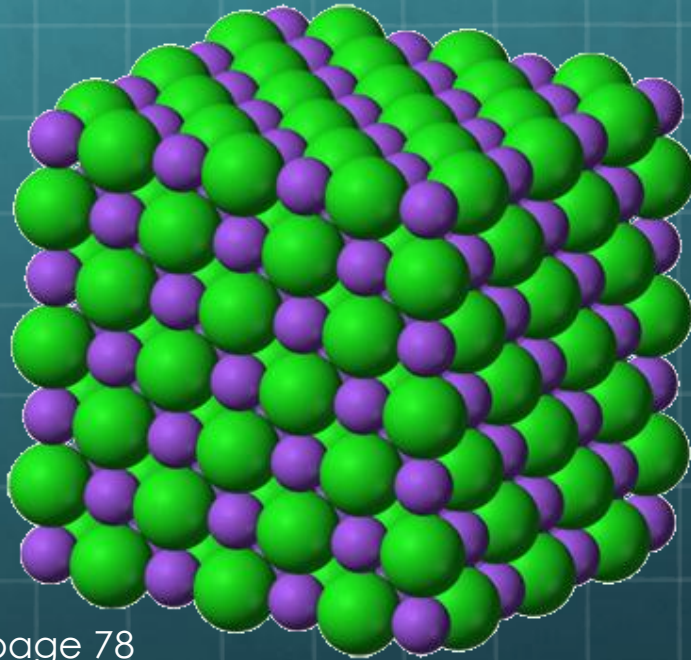
Figure 4.9 An ionic compound forms when an electron from a metal atom transfers to a non-metal atom, creating oppositely charged ions.

Ionic Compounds

Ionic solids exist as a solid in the form of an ionic lattice.

The positive ions attract all of the negative ions, and vice versa.

In the example of table salt (NaCl) the one-to-one ratio of ions results in a simple square-shaped ionic crystal:



See page 78

- An ionic compound is composed of a metal ion and non-metal ion.
- Electrons are transferred.

CHAPTER 3**Drawing Ionic Compounds****BLM 1-39**

Goal • Demonstrate your knowledge of ionic compounds.

1. In the table below, complete the blanks and draw diagrams to show how each pair of atoms forms bonds. The first example is provided for you.

Number of Electrons in Each Element	Arrangement in Electron Shells	Diagram
NaCl Na <u>11 electrons</u> Cl <u>17 electrons</u>	<u>2,8,1</u> <u>2,8,7</u>	
CaO Ca _____ O _____	_____ _____	
CaF ₂ Ca _____ F _____	_____ _____	
K ₂ S K _____ S _____	_____ _____	

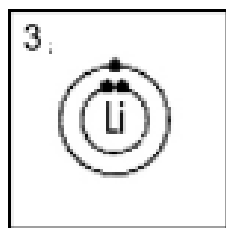
Questions

1. Use the words from the list to fill in the blanks in the paragraph below.

attract, charge, electron, ionic bond, negative, negatively charged, opposite, positive, positively charged, transferred,

- (a) When an atom gains or loses a(n) electrons, an ion is formed. All ions have a(n) charge.
- (b) Metals tend to form positive ions. Non-metals tend to form Negative ions.
- (c) When a metal atom reacts with a non-metal atom, one or more electrons are transferred, which results in the formation of ions. One of these ions will be Negatively charged and one will be positively charged. Because of these opposite charges, the ions attract each other, forming a(n) ionic bond.

2. (a) Draw a model Bohr diagram for lithium in the space provided.



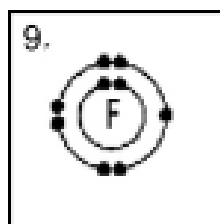
(b) What process or change would turn this lithium atom into an ion?

This atom would become an ion if it lost one electron.

(c) Would the ion that it forms be positively or negatively charged? Explain.

This lithium ion would be positively charged because it has lost an electron.

3. (a) Draw a Bohr model diagram for fluorine in the space provided.



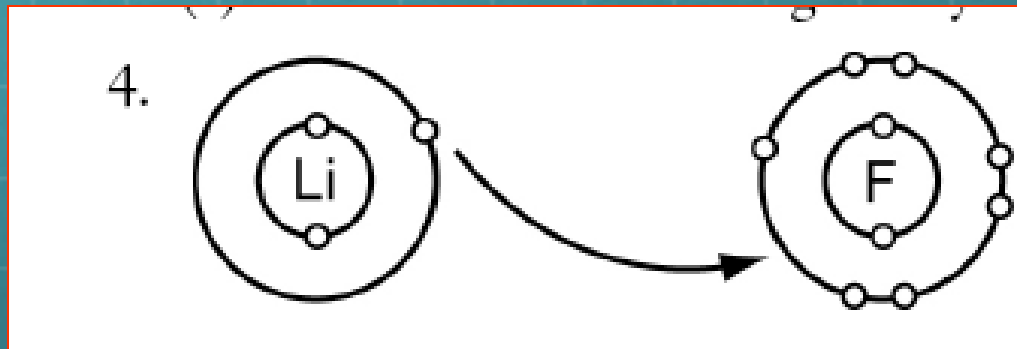
(b) What process or change would turn this fluorine atom into an ion?

This atom would become an ion if it lost one electron.

(c) Would this ion be positively charged or negatively charged? Explain.

This ion would be negatively charged because it has gained an electron.

4. Lithium and fluorine react to form lithium fluoride. Draw a diagram on the back of this page to show how these two atoms would react.

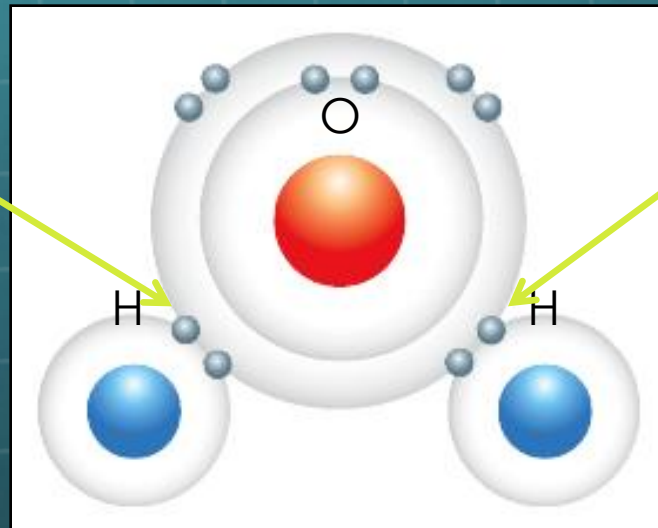


Covalent Compounds

Covalent compounds share electrons to form molecules.

Example: water

Shared electrons!



Shared electrons!

See pages 76 - 78

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CLASS:

CHAPTER 3

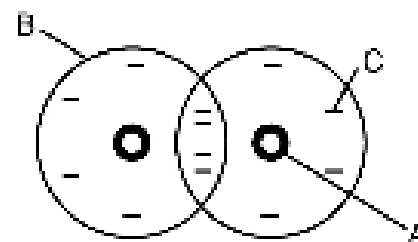
Covalent Bonding

BLM 1-35

Goal • Practise drawing bonding diagrams for covalent compounds.

What to Do

The drawing at right represents a covalent compound. Study this diagram then answer the following questions.



In an O_2 molecule, two pairs of electrons are shared.

Analyze

1. What does the small circle (A) represent? _____
2. What does the larger circle (B) represent? _____
3. What does the dash (C) represent? _____
4. The large circles overlap. What does this represent?

5. Why are there four dashes inside the overlapped area? _____

6. How many electrons are in the outer shell of the oxygen atom on the left? _____

7. How many electrons are in the oxygen atom on the right? _____

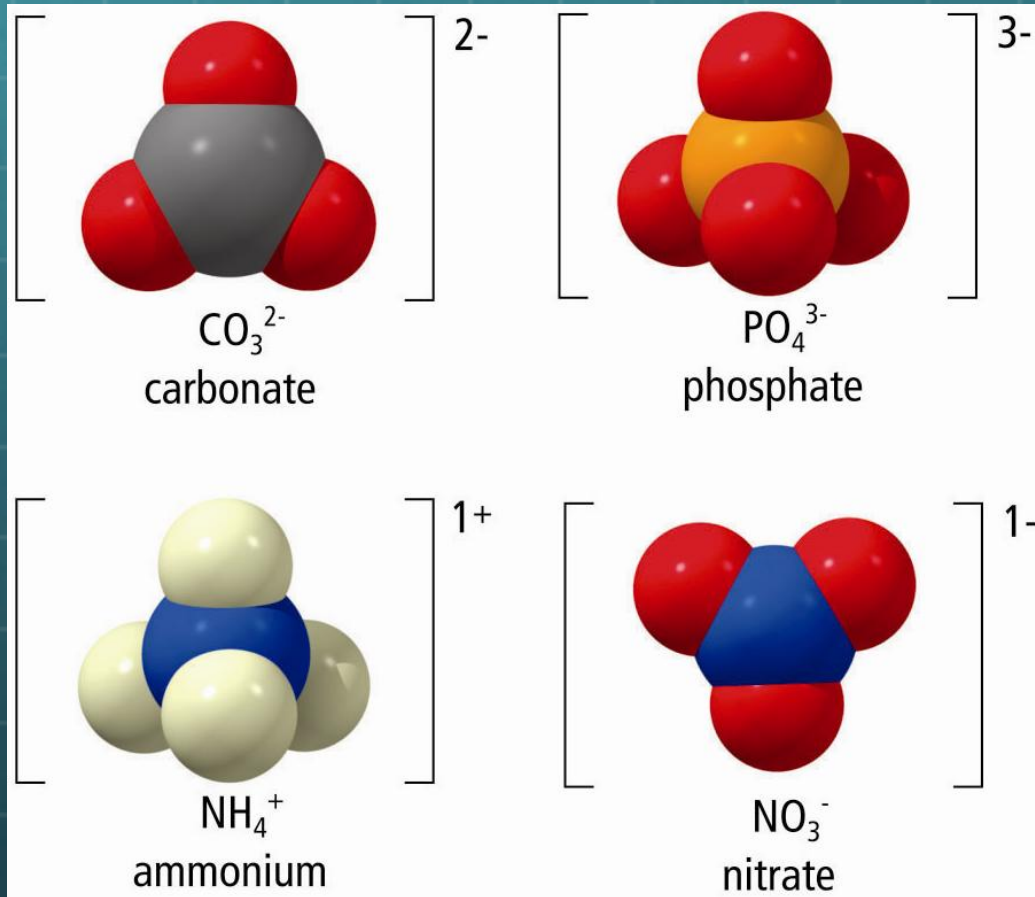
8. Explain how a covalent bond differs from an ionic bond.

9. Draw diagrams to show how each of the covalent compounds below is formed by covalent bonding.

HCl
OF ₂

BCl
NH ₃

Polyatomic ions



Polyatomic ions

- Polyatomic ions are covalently bound molecules with an electric charge.
- The electric charge can be negative or positive

Your textbook has a complete list of polyatomic ions in Table 3.10 on p.92 - check it out now!

Questions to Consider:


1. Find an ion with a positive charge
2. Find an ion with a negative charge
3. Find the 4 ions that have only 2 atoms
4. Which ion has the most atoms?
5. Which ion has the biggest charge?



Names and Formulas of Ionic Compounds

Section 3.2

A compound has both a name and a formula

-  The International Union of Pure and Applied Chemistry (IUPAC) is a group that represents chemists around the world and is responsible for the rules of naming compounds.

The Chemical Name of an Ionic Compound

Ionic compounds are composed of positive ions and negative ions.

The name of an ionic compound = positive ion + negative ion *-ide*.

Example 1 MgO

The positive ion is the first part of the name, magnesium.

The negative ion forms part of the ending of the name, oxygen.

Add *-ide* to the end of the name to form magnesium oxide.

1. What is the name of Ca_3N_2 ?

Ca, the positive ion, is calcium

N, the negative ion, is nitrogen

Drop the end of the negative ion and add *-ide*
calcium nitride

2. What is the name of NaCl ?

3. What is the name of Li_3N ?

The non-metal ions name always ends in “-ide “

- Fluorine becomes fluoride
- Chlorine becomes chloride
- Bromine becomes bromide
- Iodine becomes iodide
- Oxygen becomes oxide
- Sulphur becomes sulphide
- Selenium becomes selenide
- Nitrogen becomes nitride
- Phosphorous becomes phosphide
- Carbon becomes carbide

**Now try the practice
problems on page 86**

ODD ONLY

The Chemical Formula of an Ionic Compound

1. In an ionic compound, the positive charges balance out the negatives.
2. The subscript gives the ratio of each type of ion in the compound.
3. The ratio is always written in reduced form.

Example: What is the formula for magnesium phosphide?

Step 1: find ion charges using the periodic table

Magnesium is Mg^{2+} Phosphorous is P^{3-}

Step 2: Do the charges = zero?



Mg^{2+}	P^{3-}
Mg^{2+}	P^{3-}
Mg^{2+}	
+6	-6

**Now try the practice
problems on page 87**

BLM 1-36, One Common Ion Charge

Elements to Combine	Ions (optional)	Formula	Name	Number of Atoms in Formula
lithium fluorine	Li^+ F^-	LiF	lithium fluoride	2
lithium oxygen	Li^+ O^{2-}	Li_2O	lithium oxide	3
sodium nitrogen	Na^+ N^{3-}	Na_3N	sodium nitride	4
magnesium chlorine	Mg^{2+} Cl^-	MgCl_2	magnesium chloride	3
calcium sulphur	Ca^{2+} S^{2-}	CaS	calcium sulphide	2
strontium phosphorus	Sr^{2+} P^{3-}	Sr_3P_2	strontium phosphide	5
aluminum bromine	Al^{3+} Br^-	AlBr_3	aluminum bromide	4

BLM 1-36, One Common Ion Charge

silver nitrogen	Ag^+	N^{3-}	Ag_3N	silver nitride	4
zinc iodine	Zn^{2+}	I^-	ZnI_2	zinc iodide	3
cesium selenium	Cs^+	Se^{2-}	Cs_2Se	cesium selenide	3
scandium sulphur	Sc^{3+}	S^{2-}	Sc_2S_3	scandium sulphide	5
sodium oxygen	Na^+	O^{2-}	Na_2O	sodium oxide	3
calcium fluorine	Ca^{2+}	F^-	CaF_2	calcium fluoride	3
gallium iodine	Ga^{3+}	I^-	GaI_3	gallium iodide	4
aluminum sulphur	Al^{3+}	S^{2-}	Al_2S_3	aluminum sulphide	5
strontium nitrogen	Sr^{2+}	N^{3-}	Sr_3N_2	strontium nitride	5
potassium phosphorus	K^+	P^{3-}	K_3P	potassium phosphide	4

Formulas of Compounds Containing a Multivalent Metal

1. Some metals are multivalent, which means they have more than one ion form.
2. On the periodic table, the most common form of the ion is listed at the top of the element's box.

25	2+
Mn	3+
	4+
Manganese	
54.9	

Metal Ion Charge and Roman Numeral

Metal Ion Charge	Roman Numeral
1+	I
2+	II
3+	III
4+	IV
5+	V
6+	VI
7+	VII

3. In the name of the compound, Roman numerals are used following the positive ion to indicate which ion was used (Table 3.5 p 88).

NO NEED TO COPY OUT
TABLE...IT IS IN YOUR
TEXTBOOK

Example: What is the formula for manganese (III) sulfide?

Manganese (III) is Mn^{3+}

Sulfur is S^{2-}

25	2+
Mn	3+
	4+
Manganese	
54.9	

Mn^{3+}	S^{2-}	
+3	-2	= -1



Mn^{3+}	S^{2-}	
Mn^{3+}	S^{2-}	
	S^{2-}	
+6	-6	= 0



QUESTION: What is the formula for vanadium (IV) oxide?

vanadium (IV) is V^{4+}

oxide is O^{2-}

V^{4+}	O^{2-}	
4+	2-	= 2+



V^{4+}	O^{2-}	
	O^{2-}	
4+	4-	= 0



VO_2

If you used the cross and drop method, you would have got to this....



Then...Reduce



**Now try the practice
problems on page 89**

ODD ONLY

Your practice for homework

-  **BLM 1-36: One Common Ion Charge**
-  **BLM 1-37 – Multiple Ion Charges**

BLM 1-36, One Common Ion Charge

Elements to Combine	Ions (optional)	Formula	Name	Number of Atoms in Formula
lithium fluorine	Li^+ F^-	LiF	lithium fluoride	2
lithium oxygen	Li^+ O^{2-}	Li_2O	lithium oxide	3
sodium nitrogen	Na^+ N^{3-}	Na_3N	sodium nitride	4
magnesium chlorine	Mg^{2+} Cl^-	MgCl_2	magnesium chloride	3
calcium sulphur	Ca^{2+} S^{2-}	CaS	calcium sulphide	2
strontium phosphorus	Sr^{2+} P^{3-}	Sr_3P_2	strontium phosphide	5
aluminum bromine	Al^{3+} Br^-	AlBr_3	aluminum bromide	4

BLM 1-36, One Common Ion Charge

silver nitrogen	Ag^+	N^{3-}	Ag_3N	silver nitride	4
zinc iodine	Zn^{2+}	I^-	ZnI_2	zinc iodide	3
cesium selenium	Cs^+	Se^{2-}	Cs_2Se	cesium selenide	3
scandium sulphur	Sc^{3+}	S^{2-}	Sc_2S_3	scandium sulphide	5
sodium oxygen	Na^+	O^{2-}	Na_2O	sodium oxide	3
calcium fluorine	Ca^{2+}	F^-	CaF_2	calcium fluoride	3
gallium iodine	Ga^{3+}	I^-	GaI_3	gallium iodide	4
aluminum sulphur	Al^{3+}	S^{2-}	Al_2S_3	aluminum sulphide	5
strontium nitrogen	Sr^{2+}	N^{3-}	Sr_3N_2	strontium nitride	5
potassium phosphorus	K^+	P^{3-}	K_3P	potassium phosphide	4

CHAPTER 3 Multiple Ion Charges**BLM 1-37**

Goal • Practise writing the names and formulas of ionic compounds with multiple ion charges.

What to Do

When the metal has a multiple ion charge, a Roman numeral indicates its charge. Complete the following chart.

Charge	Roman Numeral
1+	I
2+	II
3+	III
4+	IV
5+	V
6+	VI
7+	VII

Ions	Ions (optional)	Formula	Name	Number of Atoms in Formula
iron(II) bromide	Fe^{2+} Br^-	FeBr_2	iron(II) bromide	3
iron(III) bromide	Fe^{3+} Br^-	FeBr_3	iron(III) bromide	4
copper(I) nitride				
gold(III) chloride				
lead(IV) phosphide				
lead(II) sulphide				
nickel(III) bromide				
manganese(IV) sulphide				
uranium(VI) iodide				
rhenium(VII) fluoride				
titanium(III) nitride				

BLM 1-37, Multiple Ion Charges

Elements to Combine	Ions (optional)	Formula	Name	Number of Atoms in Formula
iron(II) bromide	Fe^{2+} Br^{-}	FeBr_2	iron(II) bromide	3
iron(III) bromide	Fe^{3+} Br^{-}	FeBr_3	iron(III) bromide	4
copper(I) nitride	Cu^{+} N^{3-}	Cu_3N	copper(I) nitride	4
gold(III) chloride	Au^{3+} Cl^{-}	AuCl_3	gold(III) chloride	4
lead(IV) phosphide	Pb^{4+} P^{3-}	Pb_3P_4	lead(IV) phosphide	7
lead(II) sulphide	Pb^{2+} S^{2-}	PbS	lead(II) sulphide	2
nickel(III) bromide	Ni^{3+} Br^{-}	NiBr_3	nickel(III) bromide	4
manganese(IV) sulphide	Mn^{4+} S^{2-}	MnS_2	manganese(IV) sulphide	3

uranium(VI) iodide	U^{6+}	I^{-}	UI_6	uranium(VI) iodide	7
rhenium(VII) fluoride	Re^{7+}	F^{-}	ReF_7	rhenium(VII) fluoride	8
titanium(III) nitride	Ti^{3+}	N^{3-}	TiN	titanium(III) nitride	2
cobalt(II) oxide	Co^{2+}	O^{2-}	CoO	cobalt(II) oxide	2
copper(II) selenide	Cu^{2+}	Se^{2-}	$CuSe$	copper(II) selenide	2
gold(I) sulphide	Au^{+}	S^{2-}	Au_2S	gold(I) sulphide	3
tin(IV) iodide	Sn^{4+}	I^{-}	SnI_4	tin(IV) iodide	5
vanadium(V) phosphide	V^{5+}	P^{3-}	V_2P_5	vanadium(V) phosphide	8

Naming Compounds containing Multivalent metals

IMPORTANT WE MUST USE ROMAN NUMERALS

Example 1: Name FeCl₃

• Step 1: Do we have a multivalent metal in the formula?

YES

• Step 2: Figure out the total charge of the negative ion

Fe ³⁺	Cl ⁻	
	Cl ⁻	
	Cl ⁻	
3+	-3	= 0

Fe³⁺ = iron (III)

So this compound is called ...

iron (III) chloride

Try the name for TiF_4

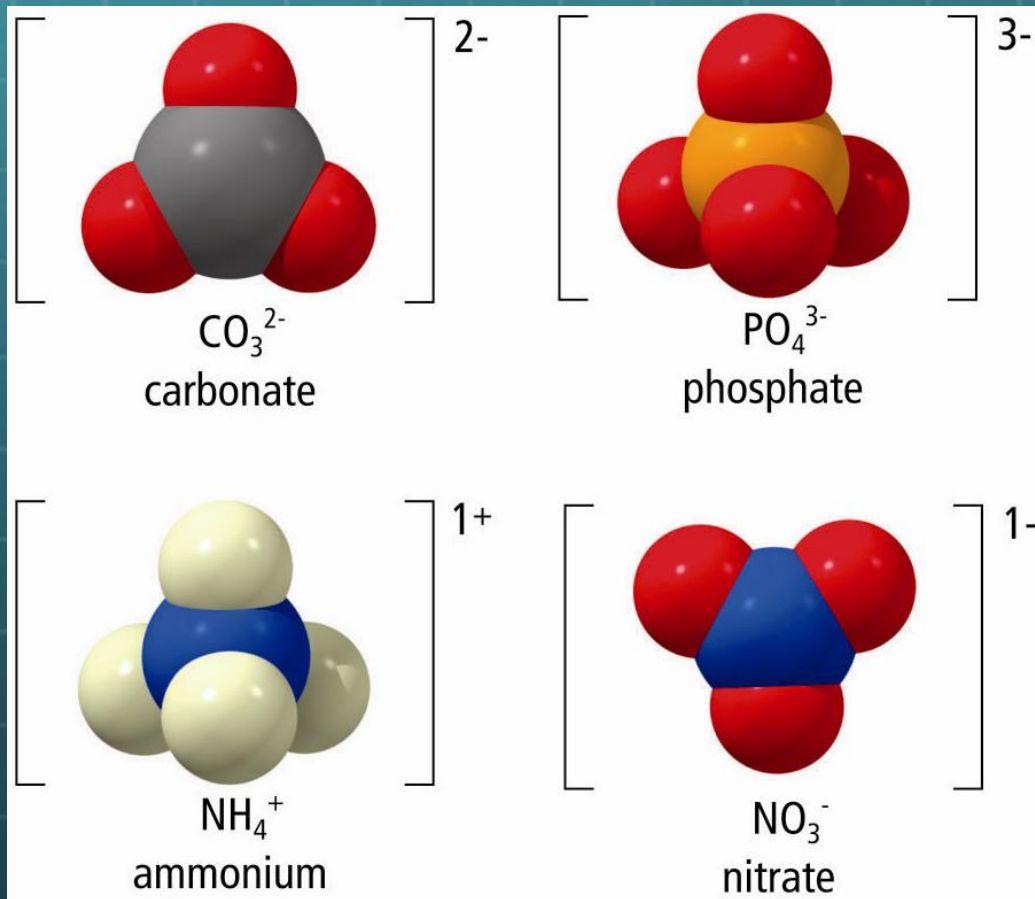
22	4+
Ti	3+
Titanium	
47.9	

Ti?	F ⁻	
	F ⁻	
	F ⁻	
	F ⁻	
?	4-	= 2+

Ti ⁴⁺	F ⁻	
	F ⁻	
	F ⁻	
	F ⁻	
4+	4-	= 0

Titanium (IV) fluoride

Remember those polyatomic ions?



Polyatomic ions

What is a Polyatomic Ion?????

Polyatomic ions are ions composed of more than one type of atom joined together by covalent bonds.

- The whole group has charge – see p. 92 for a list of polyatomics (list will be provided on quizzes & tests)
- The electric charge can be negative or positive

Positive ions act like 'metals' in ionic compounds, ie.



Negative ions act like 'non-metals' in ionic compounds, i.e.

- CO_3^{2-} (carbonate)
- NO_3^{1-} (nitrate)

Writing the NAMES for Polyatomic Compounds

Example : Name the compound KClO ?

Use the polyatomic ion table to find the name of non-metal ion

Metal ion	Non-metal ion
K^+	ClO^-
Potassium	hypochlorite

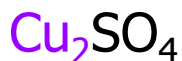
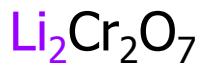
Potassium hypochlorite

Naming Polyatomic Compounds

The name of a polyatomic compound is the combination of the **metal name and the polyatomic ion name.**

Ex. sodium sulfate Na_2SO_4

Note: The **positive part** of the compound is **always** written first.



Now try the Practice Problems p91

Writing the Formula for Polyatomic Compounds

Example 1: What is the formula for sodium sulfate?

Notice the ending.... “ate”

NOT SULPHIDE – must be a polyatomic!



and



Na^+	SO_4^{2-}	
Na^+		
+2	-2	= 0



Question: What is the formula for iron (II) nitrate?

(NOT NITRIDE)



and



Fe^{2+}	NO_3^-	
	NO_3^-	
+2	-2	= +0



BLM 1-38, Polyatomic Ions

Part A

Ions		Formula	Name	Number of Atoms in Formula
Na ⁺	SO ₄ ²⁻	Na ₂ SO ₄	sodium sulphate	7
NH ₄ ⁺	SO ₄ ²⁻	(NH ₄) ₂ SO ₄	ammonium sulphate	15
Cu ²⁺	NO ₃ ⁻	Cu(NO ₃) ₂	copper(II) nitrate	9
Ag ⁺	ClO ₃ ⁻	AgClO ₃	silver chlorate	5
NH ₄ ⁺	PO ₄ ³⁻	(NH ₄) ₃ PO ₄	ammonium phosphate	20
Zn ²⁺	HCO ₃ ⁻	Zn(HCO ₃) ₂	zinc hydrogen carbonate	11
Ni ²⁺	OH ⁻	Ni(OH) ₂	nickel(II) hydroxide	5
Al ³⁺	CN ⁻	Al(CN) ₃	aluminum cyanide	7
U ⁵⁺	SO ₃ ²⁻	U ₂ (SO ₃) ₅	uranium(V) sulphite	22
Cr ²⁺	HSO ₄ ⁻	Cr(HSO ₄) ₂	chromium(II) hydrogen sulphate	13
Mn ⁴⁺	CH ₃ COO ⁻	Mn(CH ₃ COO) ₂	manganese(IV) acetate	29

Ca^{2+}	CO_3^{2-}	CaCO_3	calcium carbonate	5
Cu^{2+}	NO_2^-	$\text{Cu}(\text{NO}_2)_2$	copper(II) nitrite	7
Au^{3+}	PO_4^{3-}	AuPO_4	gold(III) phosphate	6
K^+	CrO_4^{2-}	K_2CrO_4	potassium chromate	7
Na^+	$\text{Cr}_2\text{O}_7^{2-}$	$\text{Na}_2\text{Cr}_2\text{O}_7$	sodium dichromate	11

Ions	Ions (optional)	Formula	Name	Number of Atoms
ammonium permanganate.	$\text{NH}_4^+ \text{MnO}_4^-$	NH_4MnO_4	ammonium permanganate	10
Gold(III) hydrogen sulphide	$\text{Au}^{3+} \text{HS}^-$	$\text{Au}(\text{HS})_3$	gold(III) hydrogen sulphide	7
cobalt(II) phosphate	$\text{Co}^{2+} \text{PO}_4^{3-}$	$\text{Co}_3(\text{PO}_4)_2$	cobalt(II) phosphate	13
sodium nitrate	$\text{Na}^+ \text{NO}_3^-$	NaNO_3	sodium nitrate	5
calcium nitrite	$\text{Ca}^{2+} \text{NO}_2^-$	$\text{Ca}(\text{NO}_2)_2$	calcium nitrite	7
magnesium acetate	$\text{Mg}^{2+} \text{CH}_3\text{COO}^-$	$\text{Mg}(\text{CH}_3\text{COO})_2$	magnesium acetate	15
potassium carbonate	$\text{K}^+ \text{CO}_3^{2-}$	K_2CO_3	potassium carbonate	6
uranium(VI) hydroxide	$\text{U}^{6+} \text{OH}^-$	$\text{U}(\text{OH})_6$	uranium(VI) hydroxide	13

lithium nitrite	$\text{Li}^+ \text{NO}_2^-$	LiNO_2	lithium nitrite	5
zinc perchlorate	$\text{Zn}^{2+} \text{ClO}_4^-$	$\text{Zn}(\text{ClO}_4)_2$	zinc perchlorate	9
cesium dichromate	$\text{Cs}^+ \text{Cr}_2\text{O}_7^{2-}$	$\text{Cs}_2\text{Cr}_2\text{O}_7$	cesium dichromate	11
sodium cyanide	$\text{Na}^+ \text{CN}^-$	NaCN	sodium cyanide	3
Iron(II) chromate	$\text{Fe}^{2+} \text{CrO}_4^{2-}$	FeCrO_4	iron(II) chromate	6
ammonium sulphate	$\text{NH}_4^+ \text{SO}_4^{2-}$	$(\text{NH}_4)_2\text{SO}_4$	ammonium sulphate	15
calcium hypochlorite	$\text{Ca}^{2+} \text{ClO}^-$	$\text{Ca}(\text{ClO})_2$	calcium hypochlorite	5
aluminum permanganate	$\text{Al}^{3+} \text{MnO}_4^-$	$\text{Al}(\text{MnO}_4)_3$	aluminum permanganate	16



Physical & Chemical Changes

Section 3.3

CHAPTER 3 ASSESSMENT, p. 106–107

7. (a) 2 chromium atoms and 7 oxygen atoms
(b) 2–
8. (a) Ionic
(b) Ionic
(c) Covalent
(d) Covalent
(e) Ionic
9. If the same chemical name applied to more than one compound, this would lead to confusion about which chemical is being referred to.
10. (a) International Union of Pure and Applied Chemistry
(b) One important responsibility is to develop rules for naming compounds.

Understanding Key Ideas

13. The carbonate ion CO_3^{2-} is like a molecule because the carbon and three oxygen atoms are covalently bonded to each other. It is like an ion because the group of atoms carries an electric charge of 2–.
14. (a) Sodium iodide
(b) Magnesium nitride
(c) Zinc oxide
(d) Aluminum fluoride
15. (a) Potassium nitride
(b) Calcium sulphide
(c) Silver sulphide
(d) Aluminum phosphide
(e) Strontium nitride
(f) Cesium oxide

Understanding Key Ideas

18. (a) FeF_2
(b) FeF_3
(c) CuF
(d) Cu_2O
(e) CuO
(f) SnO_2
19. (a) Ammonium phosphide
(b) Ammonium phosphite
(c) Ammonium phosphate
(d) Sodium phosphate
(e) Magnesium phosphate
(f) Iron(II) carbonate

CHAPTER 3 ASSESSMENT, p. 106–107

Understanding Key Ideas

20. (a) Na_2SO_4
(b) $\text{Ca}(\text{NO}_3)_2$
(c) $\text{Al}(\text{OH})_3$
(d) $\text{Sr}(\text{HSO}_4)_2$
(e) NH_4HSO_4
(f) $\text{Ni}(\text{ClO}_3)_3$