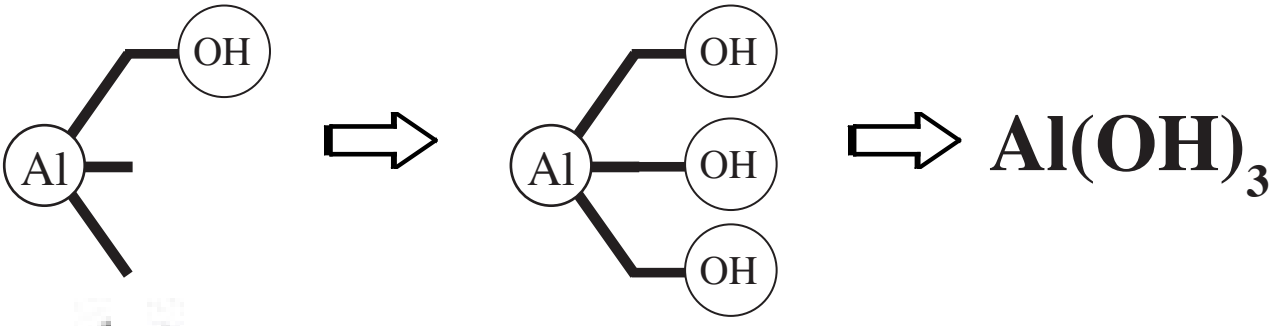
Formula & Equation Writing

Book 2



Ionic Equations

Ionic Formulae

Balanced Equations

Formula Equations

Word Equations

Transition Metals

Using Brackets

Awkward Customers

More than 2 Elements

2 Elements Only

Using the Name Only

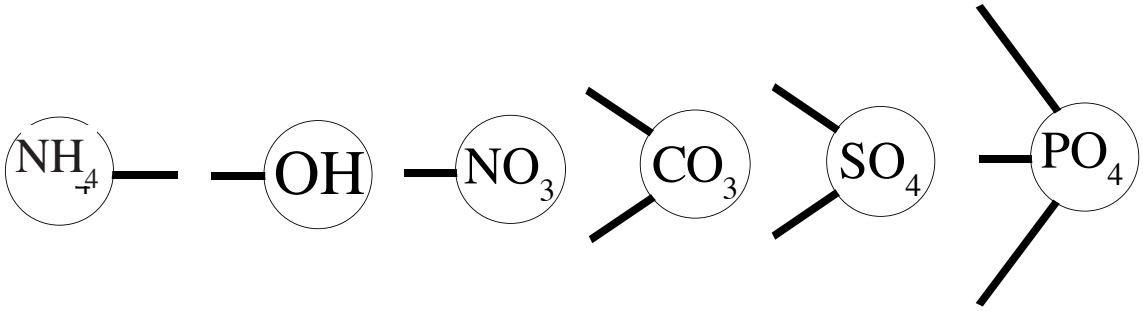
SiO_2 H_2O

$KMnO_4$

These sheets belong to _____

Group Valencies

At often join together to form "***Groups***" - *fixed numbers* of ***at*** with a certain number of ***spare bo*** still available - an overall ***group valency***.



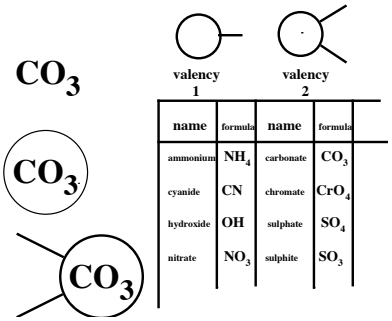
To begin with, you may have found your ***Gro*** on the other side of the special "***Per Table***" that you may have been given originally.

This will show you the ***Sym*** and the ***Val Number*** for most of the ***Gro*** you will need.

Name ⟹ **carbonate**

Symbol ⟹ CO_3

Valency Picture ⟹



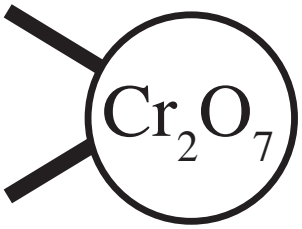
Formulae of Selected Ions containing more than one kind of Atom

one positive		one negative		two negative		three negative	
Ion	Formula	Ion	Formula	Ion	Formula	Ion	Formula
ammonium	NH_4^+	ethanoate	CH_3COO^-	carbonate	CO_3^{2-}	phosphate	PO_4^{3-}
		hydrogencarbonate	HCO_3^-	chromate	CrO_4^{2-}		
		hydrogensulfate	HSO_4^-	dichromate	$Cr_2O_7^{2-}$		
		hydrogensulfite	HSO_3^-	sulfate	SO_4^{2-}		
		hydroxide	OH^-	sulfite	SO_3^{2-}		
		nitrate	NO_3^-	thiosulfate	$S_2O_3^{2-}$		
		permanganate	MnO_4^-				

During exams you will be expected to use the Table above, which will be in the ***Data Book*** supplied.

Name ⟹ ***dichromate***

Valency picture ⟹



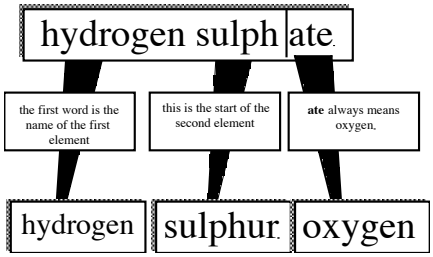
Symbol ⟹ $Cr_2O_7^{2-}$

Valency number ⟹ ***same as the amount of charge*** ⟹ ***2***

Test Yourself 6 Draw the valency picture for each of these Groups.

1. hydroxide	2. sulfate	3. ammonium	4. permanganate
5. silicate	6. phosphate	7. sulfite	8. hydrogencarbonate
9. carbonate	10. chromate	11. nitrate	12. thiosulfate

More than 2 Elements



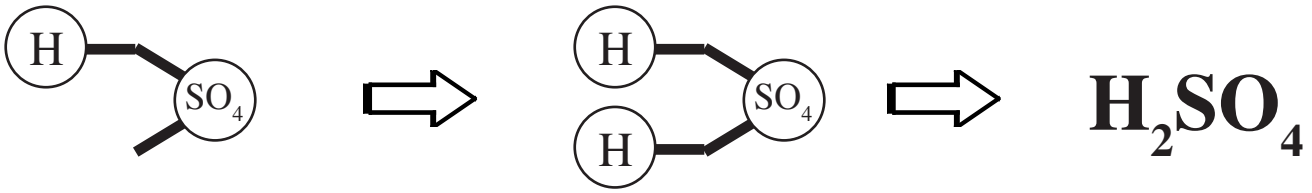
-ite
-ate

endings are used to warn that there are ***more than two elements*** in the compound.

exceptions: none

Comp may have ***more than 2 ele*** , but they will still only involve ***two parts*** :- one of which is a ***Gr*** .

For example, to work out the formula for ***hydrogen sulfate.***



1. *Draw the Valency Pictures for an atom of* ***hydrogen*** *and the* ***sulfate group****.*
2. *Draw them as shown. This valency picture is not complete.*
3. *Draw another* ***hydrogen*** *atom to complete the picture.*
4. *Now write the correct formula for* ***hydrogen sulfate****.*

Test Yourself 7 Work out the formula for each of these compounds.

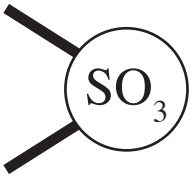
1. ammonium nitrate	2. potassium hydroxide	3. calcium sulfate
4. sodium carbonate	5. ammonium chloride	6. lithium phosphate
7. copper chromate	8. sodium sulfate	9. caesium nitrate

Awkward Customers

Some ***Gro*** are particularly ***awkward*** and you need to watch out for them.

The ***Hydroxide Gro*** is particularly ***awkward*** because it ***contains two elements*** but ends in **-IDE**.

The ***Cyanide Gro*** is particularly ***awkward*** because it ***contains two elements*** but ends in **-IDE**.

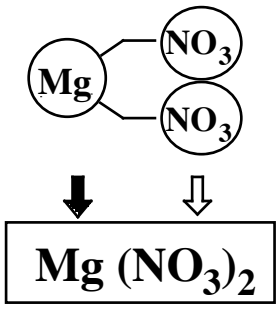


The ***Sulfite Gro*** is particularly ***awkward*** because it is very similar to the ***Sulfate Group***, SO_4.

The ***Ammonium Gro*** is particularly ***awkward*** because it ***comes at the beginning*** of the compounds name.

Using Brackets

Whenever ***two or more*** of a ***gr*** appears in a ***form*** , ***bra*** must be used to avoid confusion.



✗ $MgNO_{32}$

Wrong because it means 1Mg, 1N and 32 O atoms.

✗ MgN_2O_6

Better, but we lose the fact that we have NO_3 groups.

✔ $Mg(NO_3)_2$

Ideal. We can see the nitrate group present, and tell how many

Test Yourself 8

Work out the formula for each of these compounds.

1. lithium nitrate
2. sodium carbonate
3. magnesium sulfate
4. calcium hydroxide
5. aluminium phosphate
6. barium carbonate
7. gallium hydroxide
8. potassium phosphate
9. strontium nitrate
10. rubidium sulfate
11. magnesium sulfite
12. sodium nitrite
13. potassium permanganate
14. sodium dichromate
15. lithium chromate

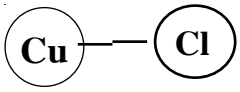
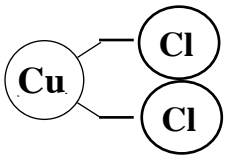
Transition Metals

The ***Tran*** ***Metals*** are awkward because they can ***cha*** ***the number of bo*** ***they use*** from ***comp*** to ***comp*** .

This problem is solved by including the ***val*** ***number*** *in the name* of the compound.

Ro ***numerals*** are used

(***I*** = one, ***II*** = , ***III*** = and ***IV*** =).

name	copper **(I)** chloride	copper **(II)** chloride
picture		
formula	**Cu Cl**	**$Cu Cl_2$**

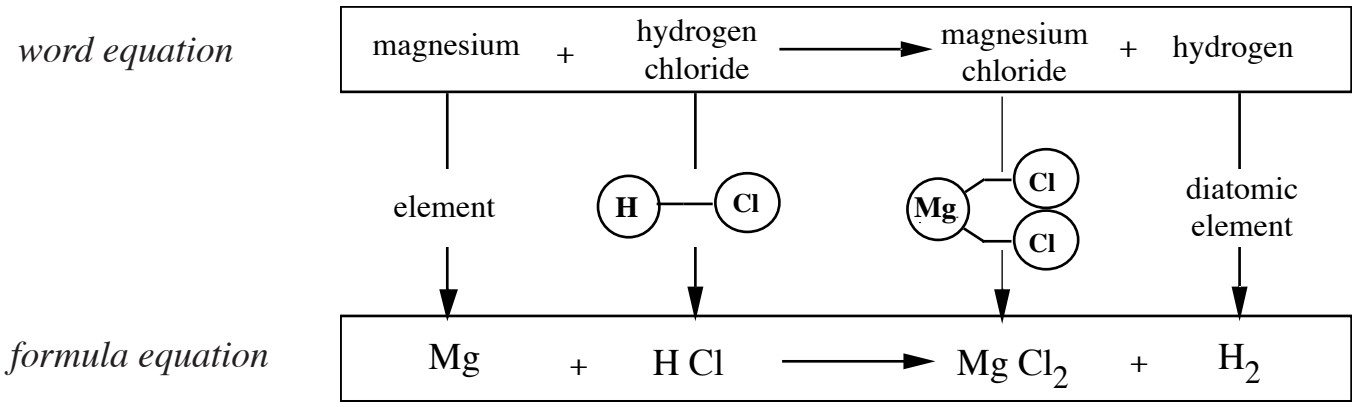
Remember that the ***Roman numeral*** tells you the ***number of bonds***, it does not tell you how many atoms should be in the formula.

Test Yourself 9 Work out the formula for each of these compounds.

1. silver (I) hydroxide
2. copper (II) chromate
3. zinc (II) carbonate
4. iron (II) hydroxide
5. copper (I) oxide
6. copper (II) oxide
7. lead (IV) oxide
8. silver (I) nitrate
9. mercury (II) chloride
10. iron (III) phosphate
11. nickel (II) chloride
12. lead (II) nitrate
13. iron (III) oxide
14. copper (II) sulfate
15. gold (III) iodide
16. nickel (II) sulfate
17. chromium (III) nitrate
18. chromium (III) oxide

Formula Equation

You should already know how to write a ***word equation*** and then replace all the ***na*** of chemicals with their ***form*** , ie write a ***Formula Equation***. e.g.



Test Yourself 10

1. Pentane (C_5H_{12}) burns in oxygen to form water and carbon dioxide.

2. Ammonia (NH_3) burns in oxygen to form water and nitrogen.

3. Zinc (II) oxide and nitric acid (HNO_3) react to form zinc (II) nitrate and water.

4. Iron (III) oxide and carbon monoxide react to give iron and carbon dioxide.

5. Potassium reacts with water to produce potassium hydroxide and hydrogen.

6. Ammonium dichromate $(NH_4)_2Cr_2O_7$ decomposes on heating to form chromium (III) oxide, water and nitrogen.

7. Phosphorus (V) oxide is formed by heating the elements together.

8. Water and carbon dioxide are produced as well as copper (II) nitrate when copper (II) carbonate reacts with nitric acid (HNO_3).

9. Ethanol (C_2H_5OH) burns in oxygen to form water and carbon dioxide.

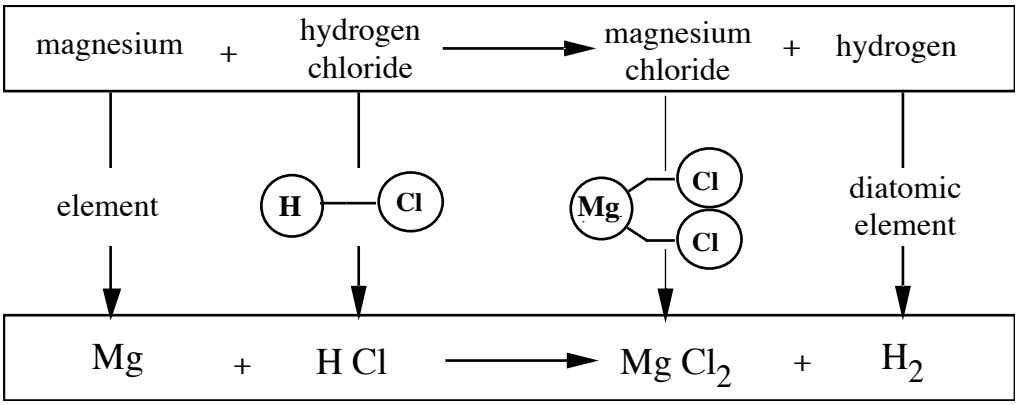
10. Nitric acid (HNO_3) and calcium hydroxide react to give water and calcium nitrate.

Balancing Equations

A ***bal*** ***equ*** has the ***same num*** ***ty*** ***of atom*** in the ***Reac*** & ***Pro*** .

In other words, *all the atoms that are there at the beginning of a reaction* (***Reac***) *must still be there at the end* (***Pro***).

If we look at an example from Book 1,



This is an ***unbalanced*** reaction, *there is **1 H** on the left but **2** on the right*
*there is **1 Cl** on the left but **2** on the right*

Equ are ***bal*** by ***increasing the am*** of some of the chemicals.

$$Mg + 2\,HCl \rightarrow MgCl_2 + H_2$$

Test Yourself 11 Balance each of the equations shown below.

1. $Fe_2O_3 + C \rightarrow Fe + CO_2$

2. $H_3PO_4 + NaOH \rightarrow Na_3PO_4 + H_2O$

3. $C_{12}H_{22}O_{11} + O_2 \rightarrow CO_2 + H_2O$

4. $NH_3 + O_2 \rightarrow NO + H_2O$

5. $Fe_2O_3 + C \rightarrow Fe_3C + CO$

6. $NH_3 + O_2 \rightarrow N_2 + H_2O$

7. $SO_2 + O_2 \rightarrow SO_3$

8. $P + C1_2 \rightarrow PC1_5$

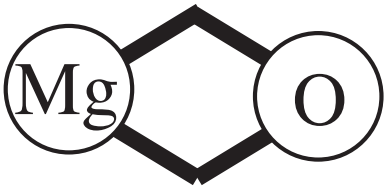
9. $B_2O_3 + C \rightarrow B_4C + CO$

10.* $C_3H_5(NO_3)_3 \rightarrow CO_2 + H_2O + N_2 + O_2$

* *If you can do this one you can certainly balance equations!!*

Ionic Formulae

There are many occasions when we want to show the ***charges*** present in ***ionic compounds*** - write ***ionic formulae***.



⇒ ***metals*** such as *magnesium* will ***lose electrons*** to form ***positive ions***

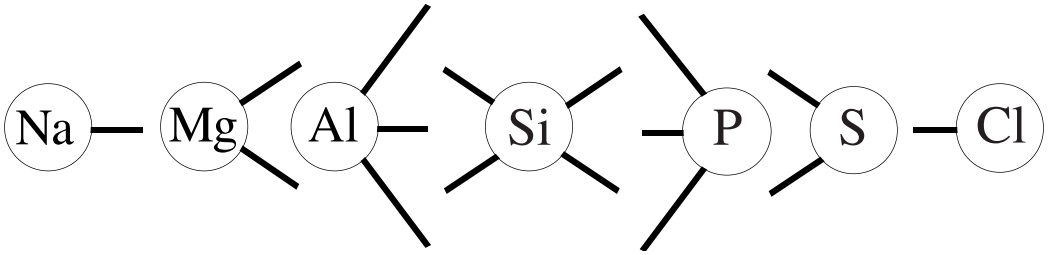
⇒ ***non-metals*** such as *oxygen* will ***gain electrons*** to form ***negative ions***

$Mg^{2+}\ O^{2-}$

Exactly like its ***Valency***, the ***charge on an ion*** depends on which ***Group*** in the Periodic Table an atom belongs to.

Group	***1***	***2***	***3***	***4***	***5***	***6***	***7***
Valency No.	***1***	***2***	***3***	***4***	***3***	***2***	***1***

Valency Pictures

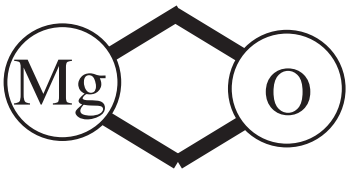


Charge on the ion	***1+***	***2+***	***3+***	***unlikely to form a simple ion***	***3-***	***2-***	***1-***

Group ions already have their ***charges*** shown in the ***Data Book***.

Formulae of Selected Ions containing more than one kind of Atom

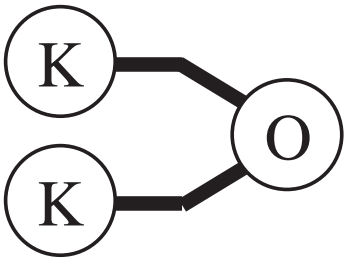
one positive		one negative		two negative		three negative	
Ion	Formula	Ion	Formula	Ion	Formula	Ion	Formula
ammonium	NH_4^+	ethanoate	CH_3COO^-	carbonate	CO_3^{2-}	phosphate	PO_4^{3-}
		hydrogencarbonate	HCO_3^-	chromate	CrO_4^{2-}		
		hydrogensulfate	HSO_4^-	dichromate	$Cr_2O_7^{2-}$		
		hydrogensulfite	HSO_3^-	sulfate	SO_4^{2-}		
		hydroxide	OH^-	sulfite	SO_3^{2-}		
		nitrate	NO_3^-	thiosulfate	$S_2O_3^{2-}$		
		permanganate	MnO_4^-				



⇒ *very little difference between the normal formula and the* ***ionic formula***

MgO

$Mg^{2+}\ O^{2-}$



⇒ ***brackets*** *, however, will be needed much more often to make clear the* ***charge*** *and* ***number*** *of ions*

K_2O

$(K^+)_2\ O^{2-}$

Test Yourself 12 Write ionic formulae for the following ionic compounds

1. sodium chloride
2. lithium iodide
3. potassium fluoride
4. rubidium bromide
5. beryllium oxide
6. calcium sulfide
7. barium bromide
8. magnesium iodide
9. lithium sulfide
10. potassium oxide
11. aluminium iodide
12. aluminium oxide
13. magnesium nitride
14. strontium chloride
15. gallium sulfide

Test Yourself 13 Write ionic formulae for the following ionic compounds

1. lithium nitrate
2. sodium carbonate
3. magnesium sulfate
4. calcium hydroxide
5. aluminium phosphate
6. barium carbonate
7. potassium phosphate
8. strontium nitrate
9. rubidium sulfate
10. magnesium sulfite
11. sodium nitrite
12. potassium permanganate
13. sodium dichromate
14. lithium chromate
15. zinc (II) carbonate
16. iron (II) hydroxide
17. copper (I) oxide
18. copper (II) oxide
19. silver (I) nitrate
20. mercury (II) chloride
21. iron (III) oxide

Ionic Equations

The main thing to remember when asked to write an ionic equation is that ***not all compounds are ionic!***

Test Yourself 14

Write ***balanced ionic equations*** for the following

1. lead nitrate → lead (II) oxide + nitrogen dioxide
2. copper (II) carbonate → copper(II) oxide + carbon dioxide
3. sodium + water → sodium hydroxide + hydrogen
4. iron (II) chloride + chlorine → iron (III) chloride
5. silver nitrate + copper (II) chloride → silver chloride + copper (II) nitrate

Going Further

You may be shown a series of videos demonstrating various reactions.

For each one, write a ***Word Equation*** and then try to write the correct ***Ionic Formula Equation***. www.new.chemistry-teaching-resources.com/EquationWriting.html

'*Further*' Set 1 - *charcoal with potassium nitrate*

Word Equation:

Formula:

'*Further*' Set 2 - *dichromate volcano*

Word Equation:

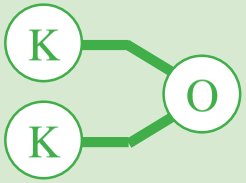
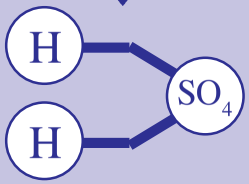
Formula:

'*Enthusiast*' Set 2 - *silver displacement*

Word Equation:

Formula:

FORMULA WRITING IN EQUATIONS

ELEMENT	ELEMENT	ELEMENT OR COMPOUND	COMPOUND	COMPOUND	COMPOUND	COMPOUND
Diatomic 7	Normal	?	Rule Breaker	2 elements	Groups	Roman Numbers
No Picture	No Picture		mono-, di- etc	ends -IDE	ends -ITE -ATE	(I) , (II) etc
			No Picture	Use Sheet	Use Sheet	Use Number Given
				Draw Picture	Draw Picture	Draw Picture
						
Write Formula	Write Symbol		Write Formula	Write Formula	Write Formula	Write Formula
O_2	Mg		CO	K_2O	H_2SO_4	CuCl