AQA Chemistry
GCSE Student calculation sheet C3.3

Name ..... Class ..... Date .....

Ionic formulae

Specification references

- C2.1.2 Ionic bonding
- C2.1.3 Ionic compounds
- MS 1c

Aims

This worksheet gives you practice in working out the formulae of a range of ionic compounds.

Learning outcomes

After completing this worksheet, you should be able to:

- describe how a Group 1 metal atom becomes a positive ion and a Group 7 non-metal atom becomes a negative ion.

Setting the scene

An ionic compound is a giant structure of ions.

An **ion** is an atom that has either lost or gained electrons to form a charged particle. The charge of a simple ion can be worked out from the electronic configuration of the atom it is made from.

Atoms either lose or gain electrons to form ions that have the electronic configuration of a noble gas. Since all atoms of Group 1 elements have one electron in their outer shell, they lose one electron to form ions with a **1+** charge. Atoms of elements in Group 2 have two electrons in their outer shell and so form ions with a **2+** charge. Similarly, atoms of elements in Group 7 have seven electrons in their outer shell, and so gain one electron to form ions with a **1–** charge, and atoms of Group 6 elements have six electrons in their outer shell and so form ions with a **2–** charge.

This logic does not apply for the ions of transition metals, which can have a variety of charges. For these metals, the charge on the ion is given in brackets in Roman numerals immediately after the name, for example, copper(II) = Cu^{2+}, iron(III) = Fe^{3+}.

You will also come across some more complicated ions, and will need to learn their formulae and charges, for example, ammonium, NH_4^+, hydroxide, OH^-, sulfate, SO_4^{2-}, nitrate, NO_3^-, and carbonate, CO_3^{2-}.

This worksheet shows you how to work out the formula of an ionic compound if you know the ions that the compound contains.

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Worked example

State the formula for the ionic compound calcium chloride.

Step 1

First write down the symbols of the two elements within the compound:

Ca and Cl

Step 2

Then determine the charge on each ion, either from the compound name or using the group each element belongs to:

Ca is in Group 2 so will lose two electrons to form a Ca^{2+} ion

Cl is in Group 7 so will gain one electron to form a Cl^{-} ion

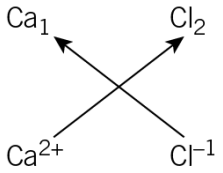
Step 3

The overall charge on the ionic compound formed must be zero. Use the charges on the ions to work out the number of each ion present in the compound:

the ions must combine in a ratio of 1 Ca^{2+} ion to 2 Cl^{-} ions

therefore the formula is $Ca^{2+}(Cl^{-})_2$ or $CaCl_2$

HINT: Note the relationship between the charges on the ions and the number of each ion present.



Questions

You will need to use a Periodic Table when answering these questions.

1 Complete the table by adding the symbol and charge for a number of common ions.

Name	Group number	Symbol including charge
calcium	2	Ca^{2+}
sodium		
fluorine		
magnesium		
oxygen		
beryllium		
sulfur		

(*6 marks*)

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2 For each of the following compounds write down the symbol and charge for each ion in the compound and use these to determine the compound's formula. For example, calcium chloride; Ca^{2+} and Cl^{-} so ionic formula is $CaCl_2$.

a sodium fluoride

.....

..... (*1 mark*)

b magnesium oxide

.....

..... (*1 mark*)

c lithium oxide

.....

..... (*1 mark*)

d magnesium chloride

.....

..... (*1 mark*)

e beryllium sulfide

.....

..... (*1 mark*)

3 For each of the following compounds, write down the symbol and charge for each ion in the compound and use these to determine the compound's formula.
You may need to read through 'Setting the scene' above to remind yourself of the formulae of some of the more complex ions.

a **i** iron(II) oxide

.....

..... (*1 mark*)

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ii manganese(II) chloride

.....

..... (*1 mark*)

iii lithium nitrate

.....

..... (*1 mark*)

iv potassium sulfate

.....

..... (*1 mark*)

v ammonium carbonate

.....

..... (*1 mark*)

b Which compound from **a i–v** contains four elements?

..... (*1 mark*)

c Which compound from **a i–v** contains seven atoms?

..... (*1 mark*)

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Student follow up

1 The table below gives the formulae of some common ions.

Positive ions		Negative ions	
hydrogen	H^+	bromide	Br^-
potassium	K^+	fluoride	F^-
lithium	Li^+	hydroxide	OH^-
ammonium	NH_4^+	nitrate	NO_3^-
copper	Cu^{2+}	oxide	O^{2-}
magnesium	Mg^{2+}	sulfide	S^{2-}
iron	Fe^{2+}	sulfate	SO_4^{2-}
zinc	Zn^{2+}	carbonate	CO_3^{2-}

a i Explain why a lithium atom forms a 1^+ ion and why an oxygen atom forms a 2^- ion.

.....

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.....

.....

..... (*4 marks*)

ii Write the formula of the compound lithium oxide.

..... (*1 mark*)

b Ammonium sulfate is a common fertiliser.

i State the formula of ammonium sulfate.

..... (*1 mark*)

ii State the number of elements in ammonium sulfate.

..... (*1 mark*)

iii State the number of atoms in ammonium sulfate.

..... (*1 mark*)

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c i Aluminium is in Group 3. Predict the charge on an aluminium ion.

..... (*1 mark*)

ii Aluminium is found naturally as its ore, bauxite. The main component of bauxite is aluminium oxide.

State the formula of aluminium oxide.

..... (*1 mark*)

Maths skills links

You will need to be able to write the formulae of ionic compounds throughout your chemistry course. You may also need to use ratios when balancing equations, calculating the amounts of substances, and working out the concentrations of solutions and the volumes of gases.