Interpreting chemical equations: ionic compounds

Introduction

These questions are designed to help you to develop mental models (pictures in your head) of what is represented by a balanced chemical equation that includes the formula of an ionic compound.

Macroscopic: what we can see. Think about the properties that we can observe, measure and record.

Sub-microscopic: smaller than we can see. Think about the particle or atomic level.

Symbolic: representations. Think about how we represent chemical ideas including symbols and diagrams.

Questions

1. Select the formula and state symbol of the products that are described. Choose from $CuSO_4(s)$, $CuSO_4(aq)$ or $MgO(s)$.

(a) Magnesium burns in oxygen to form a white solid.

_____

(b) Magnesium burns in oxygen to form a white smoke that is made up of tiny fragments of a white solid.

_____

(c) Copper carbonate powder is added to sulfuric acid to form a clear blue solution.

_____

(d) A clear blue solution is allowed to evaporate forming blue crystals.

_____

2. Sodium chloride is an ionic compound with the formula $NaCl$. Sodium chloride's structure is made up of a lattice of positively charged sodium ions (Na^+) and negatively charged chloride ions (Cl^-).

(a) Select which diagram best represents the structure of sodium chloride. Give a reason for your answer.

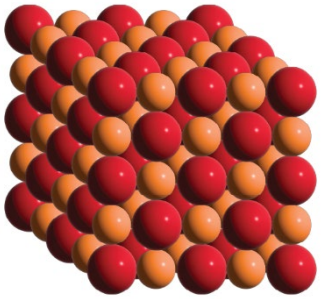

Diagram A

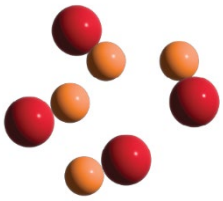

Diagram B

Cl^- ion Na^+ ion

(b) The formula for sodium chloride is $NaCl$. This could be written Na_1Cl_1 but the ones are not normally written. Complete the sentence to describe the meaning of the formula.

For every sodium ion in a sodium chloride lattice there is _____ chloride ion.

(c) Explain in terms of overall charge why the formula for sodium chloride cannot be $NaCl_2$.

3. The formula of an ionic compound shows which ions make up the ionic lattice.

(a) Complete the table to show which ions make up the ionic lattice of each compound. The first row is completed as an example.

Ionic compound	Formula	Metal ions	Non-metal ions
sodium chloride	$NaCl$	Na^+	Cl^-
magnesium chloride	$MgCl_2$	Mg^{2+}	
magnesium oxide	MgO		O^{2-}
sodium oxide	Na_2O		

(b) Complete the sentences to describe the meaning of each formula.

For each sodium ion in a sodium chloride lattice, there is _____ chloride ion.

(c) For each magnesium ion in a magnesium chloride lattice, there are _____ chloride ions.

(d) For each magnesium ion in a magnesium oxide lattice, there is _____ oxide ion.

(e) For every two sodium ions in a sodium oxide lattice, there is _____ oxide ion.

4. The chemical equation for the reaction between sodium and chlorine is:

$$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$$

(a) State whether each substance is an element, non-metal compound or a metal/non-metal compound.

i. $Na(s)$ _____

ii. $Cl_2(g)$ _____

iii. $NaCl(s)$ _____

(b) Give the structure of each substance as being a giant covalent structure, separate covalent molecules, metallic or ionic lattice.

i. $Na(s)$ _____

ii. $Cl_2(g)$ _____

iii. $NaCl(s)$ _____

(c) State whether each substance is made up of atoms, molecules or ions.

i. $Na(s)$ _____

ii. $Cl_2(g)$ _____

iii. $NaCl(s)$ _____

(d) Complete the table to show the relative number of atoms, molecules and ions that react.

Number of Mg atoms	Number of chlorine molecules	Number of Mg^{2+} ions	Number of Cl^- ions
1	1	1	2
2			
10			
1 billion			

5. The number of atoms or molecules that react in a real-life chemical reaction is so large that chemists use a special number called the mole. One mole is equal to 6.02×10^{23} atoms or molecules.

(a) For the chemical equation $Mg(s) + Cl_2(g) \rightarrow MgCl_2(s)$

Give the number of moles of magnesium chloride that can be formed from

i. One mole of magnesium atoms _____

ii. Two moles of magnesium atoms _____

(b) Chemists are able to calculate the mass of one mole of an element or compound. A chemical equation can therefore be used to work out the mass of product that could be produced from the given mass of a reactant.

The mass of one mole of magnesium is 24 g. Give the mass of two moles of magnesium. _____

(c) The mass of one mole of magnesium chloride is 95 g. Give the mass of two moles of magnesium chloride. _____

(d) Give the mass of magnesium chloride that would be formed from

i. 24 g of magnesium _____

ii. 48 g of magnesium _____