Topic	Writing chemical equations	**Level**	GCSE (or any other course for students aged 11-16)
Outcomes	Students are able to construct chemical equations by: a. considering the formulae of the reactants and products b. assigning state symbols c. balancing reactants and products		
Information for teachers	It is absolutely vital that students are able to understand the language of chemical equations, if they are going to enjoy and thrive in this subject. The purpose of this exercise is to diagnose whether students can write chemical equations. Before using this worksheet make sure that students have studied bonding, chemical formulae, state symbols and balancing equations. Where students struggle to complete the table on page 3, you can provide feedback to close any specific gaps in their understanding. Page 2 is a summary of some 'rules' for writing equations, but please be mindful that as students progress onto A Level some of these rules will no longer hold true.		

Understanding the language of chemistry

When sodium metal reacts with chlorine gas, solid sodium chloride is produced.

Let's write a chemical equation so that we can properly see what is happening.

1. **Step one: we must write the chemical formula for each reactant and product. To help us do this we need to know if each substance is ionic, covalent or metallic.**

$$Na + Cl_2 \rightarrow NaCl$$

Ionic compounds (metal+non-metal) carry no overall charge. The total charge of the positive ions must equal the total charge of the negative ions e.g. NaCl, $CaCO_3$, $CuSO_4$

Metallic elements are written using the element symbol e.g. Na or Mg

Atoms in simple covalent substances (non-metal +non-metal) share electrons so that each atom has either 2 or 8 electrons in their outer shell e.g. H_2O, NH_3, Cl_2

2. **Step two: we must add the correct state symbols.**

- ionic substances are (s) or (aq) at room temperature if dissolved in water
- metals are (s) at room temperature except mercury – this is a liquid
- simple covalent substances are (g) or (l) at room temp. or (aq) if dissolved in water
- giant covalent substances are (s) at room temperature e.g. diamond and graphite

$$Na_{(s)} + Cl_{2(g)} \rightarrow NaCl_{(s)}$$

3. **Step three: we must balance the equation to make sure there are the same number of each type of atom on either side of the arrow.** *We cannot change the formula of a chemical – we can only change how many we have.*

$$Na_{(s)} + Cl_{2(g)} \rightarrow NaCl_{(s)}$$

Step 1 – elements	**Na**	**Cl**	**Na**	**Cl**	**Balanced?**	**Comment**
Number of atoms	1	2	1	1	No	Cl not balanced

$$Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$$

Step 2 - elements	**Na**	**Cl**	**Na**	**Cl**	**Balanced?**	**Comment**
Number of atoms	1	2	2	2	No	Na not balanced

$$2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$$

Step 3– elements	**Na**	**Cl**	**Na**	**Cl**	**Balanced?**	**Comment**
Number of atoms	2	2	2	2	Yes	Balanced!

Complete the table

Mistake!!	This equation is wrong because…	This is the correct chemical equation
$Mg(s) + Cl(g) \rightarrow MgCl_2(s)$	Chlorine is diatomic and does not exist as single atoms.	
$Na(s) + O_2(g) \rightarrow NaO_2(s)$		$4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$
$C(s) + O_2(s) \rightarrow CO_2(g)$	State symbols are wrong. Oxygen is a gas at room temperature and not a solid**.**	
$Ca(s) + O_2(g) \rightarrow CaO(s)$	The equation is not balanced. There are more oxygen atoms in the reactants (2) than in the products (1).	
$H(g) + Cl(g) \rightarrow HCl(g)$		$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$
$N_2(g) + H_2(g) \rightarrow NH_3(g)$	The equation is not balanced as there is one extra nitrogen atom and one less hydrogen atom in the reactants compared to the products.	
$CH_4 + O_2 \rightarrow CO_2 + H_2O$	This equation is not balanced for oxygen and hydrogen atoms and there are no state symbols.	
$Al(s) + Br(g) \rightarrow AlBr(s)$		
$NaOH + H_2SO_4 \rightarrow NaSO_4 + H_2O$	No state symbols are written and the formula of the salt is incorrect. Sodium forms +1 ions and sulphate forms -2 ions. This would mean this compound would have a charge of -1 which would be wrong.	

Mistake!!	This equation is wrong because…	This is the correct chemical equation
$Mg(s) + Cl(g) \rightarrow MgCl_2(s)$	Chlorine is diatomic and does not usually exist as single atoms.	$Mg(s) + Cl_2(g) \rightarrow MgCl_2(s)$
$Na(s) + O_2(g) \rightarrow NaO_2(s)$	The formula of sodium oxide is incorrect. Sodium forms +1 ions and oxide forms -2 ions. We need two sodium ions for every oxide ion. The equation then needs to be balanced.	$4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$
$C(s) + O_2(s) \rightarrow CO_2(g)$	State symbols are wrong. Oxygen is a gas at room temperature and not a solid.	$C(s) + O_2(g) \rightarrow CO_2(g)$
$Ca(s) + O_2(g) \rightarrow CaO(s)$	The equation is not balanced. There are more oxygen atoms in the reactants (2) than in the products (1)	$2Ca(s) + O_2(g) \rightarrow 2CaO(s)$
$H(g) + Cl(g) \rightarrow HCl(g)$	Chlorine and hydrogen are diatomic.	$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$
$N_2(g) + H_2(g) \rightarrow NH_3(g)$	The equation is not balanced as there is one extra nitrogen atom and one fewer hydrogen atom in the reactants compared to the products.	$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
$CH_4 + O_2 \rightarrow CO_2 + H_2O$	This equation is not balanced for oxygen and hydrogen atoms and there are no state symbols.	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$
$Al(s) + Br(g) \rightarrow AlBr(s)$	The formula of aluminium bromide is incorrect. Bromine should be diatomic and is a liquid.	$2Al(s) + 3Br_2(l) \rightarrow 2AlBr_3(s)$
$NaOH + H_2SO_4 \rightarrow NaSO_4 + H_2O$	No state symbols are written and the formula of the salt is incorrect. Sodium forms +1 ions and sulphate forms -2 ions. This would mean this compound would have a charge of -1 which would be wrong.	$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$