Name: _____ Date: _____

CONTENT 14.1

14.1 Chemical Equations

READ

Chemical symbols provide us with a shorthand method of writing the name of an element. Chemical formulas do the same for compounds. But what about chemical reactions? To write out, in words, the process of a chemical change would be long and tedious. Is there a shorthand method of writing a chemical reaction so that all the information is presented correctly and is understood by all scientists? Yes! This is the function of chemical equations. You will practice writing and balancing chemical equations in this skill sheet.

What are chemical equations?

Chemical equations show what is happening in a chemical reaction. They provide you with the identities of the reactants (substances entering the reaction) and the products (substances formed by the reaction). They also tell you how much of each substance is involved in the reaction. Chemical equations use symbols for elements and formulas for compounds. The reactants are written to the left of the arrow. Products go on the right side of the arrow.

$$H_2 + O_2 \rightarrow H_2O$$

The arrow should be read as "yields" or "produces." This equation, therefore, says that hydrogen gas (H_2) plus oxygen gas (O_2) yields or produces the compound water (H_2O).

PRACTICE

Write chemical equations for the following reactions:

Reactants	Products	Unbalanced Chemical Equation
Hydrochloric acid **HCl** and Sodium hydroxide **NaOH**	Water **H_2O** and Sodium chloride **NaCl**	
Calcium carbonate **$CaCO_3$** and Potassium iodide **KI**	Potassium carbonate **K_2CO_3** and Calcium iodide **CaI_2**	
Aluminum fluoride **AlF_3** and Magnesium nitrate **$Mg(NO_3)_2$**	Aluminum nitrate **$Al(NO_3)_3$** and Magnesium fluoride **MgF_2**	

Conservation of atoms

READ

Take another look at the chemical equation for making water:

$$2H_2 + O_2 \rightarrow 2H_2O$$

Did you notice that something has been added?

The large number in front of H_2 tells how many molecules of H_2 are required for the reaction to proceed. The large number in front of H_2O tells how many molecules of water are formed by the reaction. These numbers are called *coefficients*. Using coefficients, we can balance chemical equations so that the equation demonstrates conservation of atoms. The law of conservation of atoms says that no atoms are lost or gained in a chemical reaction. The same types and numbers of atoms must be found in the reactants and the products of a chemical reaction.

Coefficients are placed before the chemical symbol for single elements and before the chemical formula of compounds to show how many atoms or molecules of each substance are participating in the chemical reaction. When counting atoms to balance an equation, remember that the coefficient applies to all atoms within the chemical formula for a compound. For example, $5CH_4$ means that 5 atoms of carbon and 20 atoms (5×4) of hydrogen are contributed to the chemical reaction by the compound methane.

Balancing chemical equations

EXAMPLE

To write a chemical equation correctly, first write the equation using the correct chemical symbols or formulas for the reactants and products.

The displacement reaction between sodium chloride and iodine to form sodium iodide and chlorine gas is written as:

$$NaCl + I_2 \rightarrow NaI + Cl_2$$

Next, count the number of atoms of each element present on the reactant and product side of the chemical equation:

Reactant Side of Equation	Element	Product Side of Equation
1	Na	1
1	Cl	2
2	I	1

For the chemical equation to be balanced, the numbers of atoms of each element must be the same on either side of the reaction. This is clearly not the case with the equation above. We need coefficients to balance the equation.

First, choose one element to balance. Let's start by balancing chlorine. Since there are two atoms of chlorine on the product side and only one on the reactant side, we need to place a "2" in front of the substance containing the chlorine, the NaCl.

$$2NaCl + I_2 \rightarrow NaI + Cl_2$$

This now gives us two atoms of chlorine on both the reactant and product sides of the equation. However, it also give us two atoms of sodium on the reactant side! This is fine—often balancing one element will temporarily unbalance another. By the end of the process, however, all elements will be balanced.

We now have the choice of balancing either the iodine or the sodium. Let's balance the iodine. (It doesn't matter which element we choose.)

There are two atoms of iodine on the reactant side of the equation and only one on the product side. Placing a coefficient of "2" in front of the substance containing iodine on the product side:

$$2NaCl + I_2 \rightarrow 2NaI + Cl_2$$

There are now two atoms of iodine on either side of the equation, and at the same time we balanced the number of sodium atoms!

In this chemical reaction, two molecules of sodium chloride react with one molecule of iodine to produce two molecules of sodium iodide and one molecule of chlorine. Our equation is balanced.

PRACTICE

Balance the following equations using the appropriate coefficients. Remember that balancing one element may temporarily unbalance another. You will have to correct the imbalance in the final equation. Check your work by counting the total number of atoms of each element—the numbers should be equal on the reactant and product sides of the equation. Remember, the equations **cannot** be balanced by changing subscript numbers!

1. $Al + O_2 \rightarrow Al_2O_3$
2. $CO + H_2 \rightarrow H_2O + CH_4$
3. $HgO \rightarrow Hg + O_2$
4. $CaCO_3 \rightarrow CaO + CO_2$
5. $C + Fe_2O_3 \rightarrow Fe + CO_2$
6. $N_2 + H_2 \rightarrow NH_3$
7. $K + H_2O \rightarrow KOH + H_2$
8. $P + O_2 \rightarrow P_2O_5$
9. $Ba(OH)_2 + H_2SO_4 \rightarrow H_2O + BaSO_4$
10. $CaF_2 + H_2SO_4 \rightarrow CaSO_4 + HF$
11. $KClO_3 \rightarrow KClO_4 + KCl$