6.1 Word Equations 216

Word equations are written in a particular format. They represent the combinations of various elements and their reactions.

Left side represents the substances initially present

The right side represents the all the products created at the end of the reaction

Reactant 1 + reactant 2 🡪 Product 1 + product 2

Some common chemical reactions

1. Rusting

Iron + oxygen 🡪 iron(III)oxide

1. Copper wire placed in sivernitrate

Copper + silver nitrate 🡪 silver + copper(II)nitrate

1. Zinc metal added to a hydrochloric acid solution

Zinc + hydrochloric acid 🡪 hydrogen + zinc chloride

1. A chemical test for hydrogen

Hydrogen + oxygen 🡪 water vapour

Examine the following word equation:

Propane + oxygen 🡪 carbon dioxide + water

1. List the reactants propane o2
2. List the products co2 water
3. What is the purpose of the arrow in the equation.

Try writing the word equations for the following reactions:

1. **CaCl2 and Na2SO4 react to form CaSO4 and NaCl**

**Calcium chloride + sodium sulfate 🡪 Calcium sulfate + sodium chloride**

1. **BaCO3 reacts when heated to produce BaO and CO2**

**Barium carbonate 🡪 barium oxide + carbon dioxide**

1. **AgNO3 reacts with KCl to produce AgCl and KNO3**

**Silver nitrate + potassium chloride 🡪 silver chloride + potassium nitrate**

Write the word equation to represent the following chemical reactions:

1. Carbon dioxide and water are produced in human cell respiration. The reactants are sugar and an important gas that humans need to survive

C6H12O6 +O2 🡪 C2O + H2O

Sugar (glucose) + oxygen 🡪 carbon dioxide + water

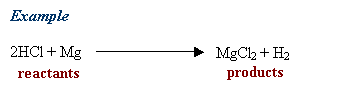
1. Stalactites form in caves when calcium bicarbonate reacts to form calcium carbonate, water and carbon dioxide gas.

Ca2CO3 🡪 CaCO3 + H2O + C2O

Calcium bicarbonate 🡪 calcium carbonate + water + carbon dioxide

6.5 Balancing Chemical Equations

A chemical equation shows the overall change of reactants to products in a chemical reaction.



Sometimes, state symbols are required to indicate the physical states of the substances in a chemical reaction.

|  |  |
| --- | --- |
| **Physical state** | **State symbol** |
| Solid | S |
| Liquid | L |
| Gas | G |
| Aqueous Solution | aq |

**Conversion of word equation to chemical equation**

***Example:***

In a precipitation reaction, sodium hydroxide solution is mixed with iron(II) chloride solution. Sodium Chloride solution and insoluble iron(II) hydroxide are produced. Write a balanced chemical equation including the state symbols.

***Solution:***

**Step 1:** Identify reactants and products and place them in a word equation,

**sodium hydroxide + iron(II) chloride → sodium chloride + iron(II) hydroxide**

**Step 2:** Convert the chemical names into chemical formulas. Place them based on the chemical equation and write the state symbols.

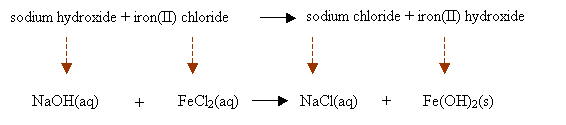
Sodium hydroxide

1. NaOH
2. Na OH with charges
3. How do you balance equations
4. Write the formula as we have been doing in the class.

Iron(II) Hydroxide FeCl2

Sodium Chloride NaCl

Iron(II)hydroxide Fe(OH)2



**Step 3**: Count the number of atoms of each type in the reactants and products. Use a chart to help

|  |  |  |
| --- | --- | --- |
| Type of Atom | Reactants | Products |
| Na | 1 | 1 |
| OH | 1 | 2 |
| Fe | 1 | 1 |
| Cl | 2 | 1 |
|  |  |  |

Type of Atom

**Step 4:** Balance the chemical equation. Multiply each of the formulas the appropriate coefficient to balance the numbers of atoms

|  |  |  |
| --- | --- | --- |
| Type of Atom | Reactants | Products |
| Na | 1 | 1 |
| OH | 1 x 2 | 2 |
| Fe | 1 | 1 |
| Cl | 2 | 1 |
|  |  |  |

Balance the equation:

NaOH(aq) + FeCl2(aq) → NaCl(aq) + Fe(OH)2(s)

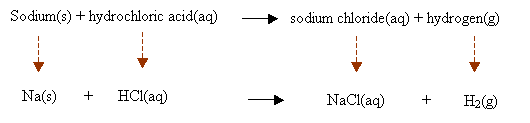
***Example:***

Write a balanced chemical equation for

Sodium(s) + hydrochloric acid(aq) → sodium chloride(aq) + hydrogen(g)

***Solution:***

**Step 1:** Convert the chemical names into chemical formulas. Place them based on the chemical equation and write the state symbols.



**Step 2:** Convert the chemical names into chemical formulas. Place them based on the chemical equation and write the state symbols.

Sodium Na

Hydrochloric acid HCl

Sodium chloride NaCl

Hydrogen H2

**Step 3:** Count the number of atoms of each type in the reactants and products. Use a chart to help

|  |  |  |
| --- | --- | --- |
| Type of Atom | Reactants | Products |
| Na | 1 | 1 |
| H | 1 | 2 |
| Cl | 1 | 1 |
|  |  |  |

**Step 4:** Balance the chemical equation. Multiply each of the formulas the appropriate coefficient to balance the numbers of atoms

|  |  |  |
| --- | --- | --- |
| Type of Atom | Reactants | Products |
| Na | 1 | 1 |
| H | 1 x2 | 2 |
| Cl | 1 | 1 |
|  |  |  |

Balance the chemical equation.

2Na(s) + 2HCl(aq) → 2NaCl(aq) + H2(g)

Another look:

<http://chemistry.about.com/cs/stoichiometry/a/aa042903a.htm>

1. **Write the unbalanced equation.**
   * Chemical formulas of reactants are listed on the lefthand side of the equation.
   * Products are listed on the righthand side of the equation.
   * Reactants and products are separated by putting an arrow between them to show the direction of the reaction. Reactions at equilibrium will have arrows facing both directions.
2. **Balance the equation.**
   * Apply the [Law of Conservation of Mass](http://chemistry.about.com/library/glossary/bldef5660.htm) to get the same number of atoms of every element on each side of the equation. Tip: Start by balancing an element that appears in only *one* reactant and product.
   * Once one element is balanced, proceed to balance another, and another, until all elements are balanced.
   * Balance chemical formulas by placing coefficients in front of them. Do not add subscripts, because this will change the formulas.
3. **Indicate the states of matter of the reactants and products.**
   * Use (g) for gaseous substances.
   * Use (s) for solids.
   * Use (l) for liquids.
   * Use (aq) for species in solution in water.
   * Write the state of matter immediately following the formula of the substance it describes.

**Worked Example Problem**

Tin oxide is heated with hydrogen gas to form tin metal and water vapor. Write the balanced equation that describes this reaction.

1. **Write the unbalanced equation.**

SnO2 + H2 --> Sn + H2O

Refer to [Table of Common Polyatomic Ions](http://chemistry.about.com/library/weekly/bl040903a.htm) and [Formulas of Ionic Compounds](http://chemistry.about.com/library/weekly/bl041303a.htm) if you have trouble writing the chemical formulas of the products and reactants.

1. **Balance the equation.**

Look at the equation and see which elements are not balanced. In this case, there are two oxygen atoms on the lefthand side of the equation and only one on the righthand side. Correct this by putting a coefficient of 2 in front of water:

SnO2 + H2 --> Sn + 2 H2O

This puts the hydrogen atoms out of balance. Now there are two hydrogen atoms on the left and four hydrogen atoms on the right. To get four hydrogen atoms on the right, add a coefficient of 2 for the hydrogen gas. Remember, coefficients are multipliers, so if we write 2 H2O it denotes 2x2=4 hydrogen atoms and 2x1=2 oxygen atoms.

SnO2 + 2 H2 --> Sn + 2 H2O

The equation is now balanced. Be sure to double-check your math! Each side of the equation has 1 atom of Sn, 2 atoms of O, and 4 atoms of H.

1. **Indicate the physical states of the reactants and products.**

To do this, you need to be familiar with the properties of various compounds or you need to be told what the phases are for the chemicals in the reaction. Oxides are solids, hydrogen forms a diatomic gas, tin is a solid, and the term 'water vapor' indicates that water is in the gas phase:

SnO2(s) + 2 H2(g) --> Sn(s) + 2 H2O(g)

This is the balanced equation for the reaction.

**Worksheets for Practicing Balancing Equations**

Here are some worksheets with answers you can download and print to practice balancing equations:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1. | **Fe** | **+** | **H2S04** | **Fe2(SO4)3** | **+** | **H2** |
| 2. | **C2H6** | **+** | **O2** | **H2O** | **+** | **CO2** |

* [Practicing Balancing Chemical Equations - Worksheet](http://chemistry.about.com/library/formulabalance.pdf)
* [Balancing Chemical Equations - Answers](http://chemistry.about.com/library/formulabalanceanswer.pdf)
* [Practicing Balancing Chemical Equations - Worksheet #2](http://chemistry.about.com/library/formulabalance2.pdf)
* [Balancing Chemical Equations - Answers #2](http://chemistry.about.com/library/formulabalance2answers.pdf)
* [Practicing Balancing Chemical Equations - Worksheet #3](http://chemistry.about.com/library/formulabalance3.pdf)
* [Balancing Chemical Equations - Answers #3](http://chemistry.about.com/library/formulabalance3answers.pdf)