**Year 10 Chemical Sciences**

**Week 6 and 7 – Chemical Reactions**

**Objectives:**

* Define an acid as a substance that produces H+ ions in solution and define a base as a substance that produces OH- ions in solution.
* Know the formula and name of the acids: H2SO4, H2CO3, HNO3, HCl, H3PO4, CH3COOH.
* Know the formula and name of some common bases.
* Know the general reaction types and associated observations:
* Use coefficients to balance a partially completed equations (given formula)
* Write balanced equation and word equation.
* Predict the formula of the products or reactants for the above reaction types given either the reactant or products.
* Write the balanced equations for the above reaction types given the formula and names of the reactants

**Acids**

Acids are substances that produce hydrogen ions (H+1) when they are dissolved in water. Most non-metal oxides are also acidic.

The common acids and their formulas that you need to know are:

|  |  |
| --- | --- |
| Hydrochloric Acid | HCl |
| Nitric Acid | HNO3 |
| Sulfuric Acid | H2SO4 |
| Phosphoric Acid | H3PO4 |
| Carbonic Acid | H2CO3 |
| Ethanoic Acid | CH3COOH |

**Bases**

Bases are substances that produce hydroxide ions (OH-1) when they are dissolved in water. All metal oxides and metal hydroxides are basic substances.

Some common bases that you should know are:

|  |  |
| --- | --- |
| Sodium hydroxide | NaOH |
| Potassium hydroxide | KOH |
| Magnesium hydroxide | Mg(OH)2 |
| Iron (III) Oxide | Fe2O3 |
| Copper (II) Oxide | CuO |
| Aluminium Oxide | Al2O3 |

**General Reactions**

The following list of general reactions helps us to predict products formed when reacting two substances together. It is important that you know these general reactions as you will not be able to write chemical equations without them.

1. ***acid + metal → salt + hydrogen gas***

e.g. H2SO4 + **2**Na → Na2SO4 + H2

1. ***acid + carbonate→ salt + water + carbon dioxide gas***

e.g. H2SO4 + Na2CO3 → Na2SO4 + H2O + CO2

1. ***acid + base (metal hydroxide) → salt + water***

e.g. H2SO4 + **2**NaOH → Na2SO4 + **2**H2O

1. ***acid + base 🡪 salt + water***

e.g. H2SO4 + Na2O → Na2SO4 + H2O

1. ***acid + hydrogen carbonate→ salt + water + carbon dioxide gas***

e.g. H2SO4 + **2**NaHCO3 → Na2SO4 + **2**H2O + **2**CO2

1. ***carbonate*** $→$ ***metal oxide + carbon dioxide gas***

e.g. Na2CO3 → Na2O + CO2

1. ***hydrogencarbonate*** $→$ ***metal carbonate + water + carbon dioxide gas***

e.g. **2**NaHCO3 → Na2CO3 + H2O + CO2

1. ***metal + oxygen → metal oxide***

e.g. **4**Na + O2 → **2**Na2O

1. ***non-metal + oxygen → non-metal oxide***

e.g. C + O2 → CO2

**Balancing Chemical Equations**

The law of conservation of mass states:

In a closed or isolated system, matter cannot be created or destroyed. It can change forms but is conserved.

In the context of chemistry this means that the mass of reactants is always equal to the mass of products which means that the number of atoms of each element involved in a chemical reaction must remain constant.

The steps to writing balanced chemical equations are as follows:

Step 1: Write the word equation for the reaction which includes all the reactants and all the products

Step 2: Under each of the reactants and products write its correct chemical formula

Step 3: Where necessary, place a coefficient in front of each formula to balance the number of atoms of each element on both sides of the equation. **DO NOT CHANGE THE ACTUAL FORMULAS IN ANY WAY!**

A good order to do this in is to follow the MINOH method. (Me know chemistry!)

**M** – **M**etals. Balance metals such as Na and Fe first

**I**  – Polyatomic **I**ons. Balance any polyatomic ions in the reaction that cross from reactant to product unchanged. e.g. SO4-2

**N**  – **N**on-metals not involved in a polyatomic ion should then be balanced. Look for Cl or S as they are common ones.

**O** – **O**xygen atoms are balance next

**H**  – **H**ydrogen atoms should be balanced last

Step 4: Check that the number of atoms of each element is the same on both sides of the equation and are in the lowest possible whole number ratio.

**NOTE – Ionic Equations**

Remember that when writing ionic equations, only the ions that are participating in the reaction are included in the equation. Identify these by first determining the solids (precipitates) formed in the reaction. Ionic equations also must be balanced for charge as well as for atoms and subscripts for the states of matter should also be included: (s) for solid, (aq) for aqueous, (l) for liquid, (g) for gas.

**EXAMPLE 1:** Sulfuric acid is reacted with Iron (III) oxide. Write a fully balanced equation for this reaction.

Step 1: sulfuric acid + iron (III) oxide 🡪 iron (III) sulfate + water

Step 2: H2SO4 + Fe2O3 🡪 Fe2(SO4)3 + H2O

Step 3: **3**H2SO4 + Fe2O3 🡪 Fe2(SO4)3 + **3**H2O

Step 4:

|  |  |  |
| --- | --- | --- |
| Reactants | = | Products |
| 6 | H | 6 |
| 1 | S | 1 |
| 15 | O | 15 |
| 2 | Fe | 2 |

**EXAMPLE 2:** Write a balanced **ionic equation** for the reaction between sodium sulfate and barium hydroxide.

Step 1: sodium sulfate + barium hydroxide 🡪 sodium hydroxide + barium sulfate

Step 2: Na2SO4 (aq) + Ba(OH)2 (aq)  🡪 NaOH (aq) + BaSO4 (s)

Step 3:Ba+2(aq) +SO4-2 (aq) 🡪 BaSO4 (s)

Step 4:

|  |  |  |
| --- | --- | --- |
| Reactants | = | Products |
| 1 | Ba | 1 |
| 1 | S | 1 |
| 4 | O | 4 |
| +2-2 = 0 | charge | 0 |

**Questions**

1. Balance the following equations.
2. Zn + HCl → ZnCl2 + H2
3. H2S + O2 → SO2 + H2O
4. C4H10 + O2 → CO2 + H2O
5. Complete the word equations and then write balanced chemical equations for each of the following reactions.
	1. hydrochloric acid + sodium carbonate 🡪
	2. magnesium + oxygen 🡪
	3. sulfuric acid + magnesium oxide 🡪
	4. potassium hydrogencarbonate (+ heat) 🡪
	5. zinc + nitric acid 🡪
	6. calcium carbonate (+ heat) 🡪
6. For each of the following reactions write balanced ionic equations for any reactions where a precipitate will be formed. If a precipitate is not formed write NR.
	1. Sodium chloride and lead (II) nitrate
	2. Barium nitrate and potassium sulfate
	3. Lead (II) nitrate and sodium iodide
	4. Copper (II) chloride and zinc nitrate