**16.1 / 16.2 Redox Reactions**

Many of the chemical reactions that play a role in maintaining our environment are **oxidation-reduction** reactions. These reactions are commonly known as **redox reactions.**

Examples include the reactions of water and gases that cause corrosion and are also used in the processing of mineral ores to extract the metals that we use today. Redox reactions also include respiration and photosynthesis, the burning of fuels including petrol and coal, the manufacture and use of explosives, the use of electrolysis to produce chemicals and the production and use of fertilisers.

In the early days of chemistry the reaction of elements and compounds with the element oxygen was classified as **oxidation** which then meant the addition of oxygen. When oxygen reacts with an element the element is said to be oxidised.

C(s) + O2(g) CO2(g)

4Fe(s) + 3O2(g) 2Fe2O3(s)

There are no large deposits of iron found on earth, because elemental iron reacts with oxygen to form various mineral oxide ores such as haematite (Fe2O3) and magnetite (Fe3O4)

The iron we use has been extracted from iron ores. This extraction process involves the removal of oxygen from the ion to give iron. The iron ore has been **reduced** and the process is called **reduction.**

The production of iron from haematite is represented by the equation:

Fe2O3(s) + 3CO(g) 2Fe(s) + 3CO2(g)

The iron(III) oxide has lost oxygen – it has been reduced.

**Reduction cannot occur without oxidation occurring at the same time.**

The carbon monoxide has gained oxygen and is said to be oxidised.

**Oxidation and reduction always occur simultaneously.**

**An Improved Definition: Electron Transfer.**

Many similar reactions occur but they don’t involve oxygen. The reaction of sodium with chlorine can be called chlorination. So a new definition was required that focused on what all these reactions have in common.

Magnesium will react with oxygen in the atmosphere to form magnesium oxide. The magnesium has been oxidised. This reaction can be represented by the equation:

Magnesium oxide is an ionic compound, consisting of Mg2+ ions and O2- ions. Each magnesium ions must have lost two electrons to the Mg2+ ion. Each O2- ion must have gained two electrons to form the oxide ion. This reaction can be represented by two **half equations.**

So the oxidation of magnesium involves the transfer of electrons from magnesium atoms to oxygen atoms.

**Oxidation is defined as the loss of electrons. Similarly, reduction can be defined as the gain of electrons.**

You can use the following mnemonic aid to help with the definitions of oxidation and reduction.

**OIL RIG**

**O**xidation **I**s the **L**oss of electrons

**R**eduction **I**s the **G**ain of electrons

Remember that electrons are not really lost but only transferred from one atom to another.

**Example 16.2a**

When sodium reacts with chlorine gas (Cl2), sodium chloride is formed (an ionic compound). Write the two half equations to identify the substances oxidised and reduced.

**Example 16.2b**

When a strip of copper wire is suspended in a solution of silver nitrate, long slivers of silver will be formed. The solution changes to a pale blue colour, indicating the presence of Cu2+(aq) ions. Write the half equations and identify the substances oxidised and reduced.

**Complete Questions 1,2 and 3 (page 278)**

**Writing an Overall Redox Equation.**

When writing equations for redox reactions we generally write the two half equations first and then add them together to get the overall equation.

**The overall equation doesn’t show any electrons transferred – the electrons lost in the oxidation reactions are gained in the reduction reaction.**

In the previous example 16.2b:

* Each copper atom that is oxidised loses two electrons.
* Each Ag+(aq) ion that is reduced gains one electron.

So two Ag+(aq) ions must be reduced to take the electrons lost by each copper atom that is oxidised. To write the overall equation the half equation involving the reduction of Ag+(aq) is multiplied by a factor of 2 before combining the two half equations.

Remember that in both half and overall redox reactions:

* The number of atoms of each element present in the products is equal to the number present in the reactants.
* The total charge on the product side of the equation is equal to the total charge on the reactant side.

**Example 16.2c**

When sodium is oxidised by atmospheric oxygen, the reaction can be represented by the following half equations:

Identify the half reaction representing the oxidation reaction and write the balanced overall equation.

Step 1: Identify the oxidation reaction.

Step 2: From each half equation:

* Each O2 molecule needs….
* Each Na atom loses…

We therefore need Na atoms to provide sufficient electrons to reduce O2 molecule.

The oxidation half equation involving the sodium must be multiplied by before combining the other half equation.

**Oxidants and Reductants**

*The chemical term species refers to atoms, ions and molecules.*

*The terms oxidising agent, oxidant and oxidiser have the same meaning as do the terms reducing agent, reductant and reducer.*

An oxidant is a species that causes another to be oxidised.

A reductant is a species that causes another to be reduced.

The reaction between zinc and hydrochloric acid can be represented by the following equations:

Oxidation (loss of electrons) Zn(s) Zn2+(s) + 2e-

Reduction (gain of electron) 2H+(aq) + 2e-H2(g)

Remember oxidation and reduction always occur simultaneously. A species can only lose electrons if there is another species available to gain those electrons.

In the above equation the zinc has been oxidised. This can happen because the H+ ion is present to accept the electrons. The H+ ions has caused the Zn to be oxidised and is therefore called the oxidising agent or oxidant.

The Zn has caused the H+ to be reduced. So the Zn is called the reducing agent or the reductant.

In any redox reaction:

* The oxidant is the substance that causes oxidation (and is itself reduced)
* The reductant is the substance that causes reduction (and is itself oxidised)

The overall equation for the reaction is:

**Complete Questions 4 and 6**