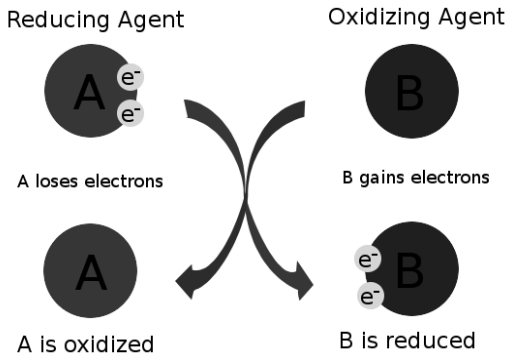
WASHINGTON LATIN PUBLIC CHARTER SCHOOL

CHEMISTRY 2019-20

UNIT 5B

CHEMICAL REACTIONS II – OXIDATION AND REDUCTION

Help with distance learning lessons



Contents

Key words: oxidation, reduction, half-equation, redox reaction, oxidizing agent, reducing agent

Lesson 1 – Introduction to Oxidation and Reduction

- Oxidation and reduction are best defined in terms of electron transfer:

Oxidation is the loss of electrons
When a species loses electrons it is said to be **oxidised**

Eg A sodium atom (Na) can lose one electron to become a sodium ion (Na^+)
This process can be represented as follows: $Na \rightarrow Na^+ + e^-$

Eg A magnesium atom (Mg) can lose two electrons to become a magnesium ion (Mg^{2+})
This process can be represented as follows: $Mg \rightarrow Mg^{2+} + e^-$

Eg An iodide ion (I^-) can lose an electron to become an iodine atom (I)
This process can be represented as follows: $I^- \rightarrow I + e^-$

Reduction is the gain of electrons
When a species gains electrons it is said to be reduced

Eg A Cl atom can gain one electron to form a Cl^- ion
This process can be represented as follows: $Cl + e^- \rightarrow Cl^-$

Eg An O atom can gain two electrons to become an oxide ion (O^{2-})
This process can be represented as follows: $O + 2e^- \rightarrow O^{2-}$

Eg An Fe^{3+} ion can lose one electron to become a Fe^{2+} ion
This process can be represented as follows: $Fe^{3+} + e^- \rightarrow Fe^{2+}$

- Remember: LEO GER (loss of electrons is oxidation, gain of electrons is reduction) or OIL RIG (oxidation is loss, reduction is gain)

- Equations such as those shown above, which show the gain or loss of electrons by a species, are known as **half-reactions** or **half-equations**

- **A redox reaction is a reaction involving the transfer of electrons**
During redox reactions, one species loses electrons and gets oxidised, whilst another gains electrons and gets reduced.

Example: $Na + Cl \rightarrow NaCl$ ($NaCl$ contains Na^+ and Cl^-)
During this reaction, Na becomes Na^+ - it loses an electron so is oxidized
During this reaction, Cl becomes Cl^- - it gains an electron so is reduced

Example: $2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$

During this reaction, $2I^-$ becomes I_2 - they lose electrons so are oxidized
During this reaction, Fe^{3+} becomes Fe^{2+} - it gains electrons so is reduced

Example: $Mg + 2HCl \rightarrow MgCl_2 + H_2$ ($HCl = H^+ + Cl^-$, $MgCl_2 = Mg^{2+} + 2Cl^-$)

During this reaction, Mg becomes Mg^{2+} - it loses an electron so is oxidized
During this reaction, $2H^+$ becomes H_2 – they gain electrons so are reduced
The Cl^- stays as Cl^- – it is neither oxidized nor reduced

Lesson 2 – Oxidizing and Reducing Agents

- In a redox reaction, the atom which is reduced is accepting electrons from the other species and causing it to be oxidised; the atom being reduced is therefore an **oxidising agent**; an oxidising agent is an **electron acceptor**; it causes the atom it reacts with to be oxidized

- The atom which is oxidized is donating electrons to another atom and causing it to be reduced; the atom being oxidized is therefore a **reducing agent**; a reducing agent is an electron donor; it causes the atom it reacts with to be reduced

- A redox reaction can thus be described as a transfer of electrons from a reducing agent to an oxidising agent

Eg $Na + Cl \rightarrow NaCl$
In this reaction Na is oxidized ($Na \rightarrow Na^+ + e^-$) so Na is the reducing agent
In this reaction Cl is reduced ($Cl + e^- \rightarrow Cl^-$) so Cl is the oxidizing agent

Eg $2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$
In this reaction I^- is oxidized ($2I^- \rightarrow I_2 + 2e^-$) so I^- is the reducing agent
In this reaction Fe^{3+} is reduced ($Fe^{3+} + e^- \rightarrow Fe^{2+}$) so Fe^{3+} is the oxidizing agent

Eg $Mg + 2HCl \rightarrow MgCl_2 + H_2$
In this reaction Mg is oxidized ($Mg \rightarrow Mg^{2+} + 2e^-$) so Mg is the reducing agent
In this reaction H^+ is reduced ($2H^+ + 2e^- \rightarrow H_2$) so H^+ is the oxidizing agent

- Note - not all reactions are redox reactions; in acid-base reactions, it is H^+ ions, not electrons, which are transferred; the charges on the atoms do not change:

Eg	CaO +	$2HCl \rightarrow$	$CaCl_2$ +	H_2O
Charges:	+2, -2	+1, -1	+2, -1	+1, -2

If the charges on the atoms do not change, the reaction is NOT a redox reaction

- Oxidizing agents are useful as disinfectants and in treating wounds, as the oxidation of microbes tends to kill them:
  - Swimming pools contain Cl_2, chlorox contains NaClO and I_2 is used to sterilize wounds
  - Cl_2, NaClO and I_2 are all oxidizing agents

- Reducing agents are often added to food to stop it going bad (due to oxidation); they are often referred to as "anti-oxidants"
  - Na_2SO_3 is a reducing agent; it is often added to wine (to prevent the alcohol from being oxidized into vinegar) and to some food (so they don't go bad as quickly)