

Redox and other driving forces

Part 9

Reaction Types

- Combination
- Decomposition
- Single Replacement
- Double Replacement
- *Combustion*

This is not a comprehensive list!

Driving Forces

- Transfer of electrons. (Also called Redox or oxidation/reduction reactions)
- Formation of a solid
- Formation of a gas
- Formation of water

Combination Reaction

- Pattern: $A + B \rightarrow AB$
- Can be recognized because there is only one product.
- Example: $2 \text{Mg} + \text{O}_2 \rightarrow 2 \text{MgO}$
- Driving force is often the transfer of electrons.

Oxidation-Reduction

- Oxidation-Reduction reactions, often called 'Redox Reactions', are another way to classify chemical reactions.
- Redox reactions are simply classified as reactions where the oxidation state (charge) of the species involved changes during the chemical reaction.

'Redox'

- The term 'Redox' comes from the concatenation of the terms "Oxidation" and "Reduction".
- Redox reactions are characterized by *Electron Transfer* between an electron donor and electron acceptor

Example: Combination

- For the following reaction determine which substance gets oxidized and which substance gets reduced.
- Loss of Electrons is Oxidation
- Gain of Electrons is Reduction
- LEO the lion says GER
- $2 \text{Mg} + \text{O}_2 \rightarrow 2 \text{MgO}$

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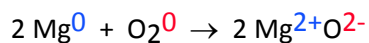
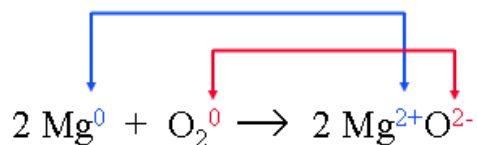
• $2 \text{Mg} + \text{O}_2 \rightarrow 2 \text{MgO}$

Example

• Use your knowledge of the periodic table to determine the oxidation states of each of the species.

– Remember that species in their ‘natural’ state (uncombined) have oxidation numbers of zero.

Therefore:

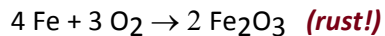


Mg is Oxidized. Mg lost $2 e^-$.

O_2 is Reduced. O gained $2 e^-$.

Keys for Combination Reactions

- If there is one product, it is a combination reaction.
- Most combination reactions are Redox Reactions, look for the charge changing.
- Example:

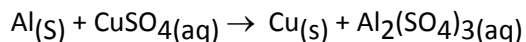


Decomposition Reactions

- Pattern: $\text{AB} \rightarrow \text{A} + \text{B}$
- Can be recognized because there is only one reactant.
- Driving force is often the transfer of electrons.
- Example: $2 \text{ H}_2\text{O} \rightarrow 2 \text{ H}_2 + \text{O}_2$

Single Replacement

- Pattern: $\text{A} + \text{BC} \rightarrow \text{B} + \text{AC}$
- A goes from elemental state to ionic state.
- B goes from ionic state to elemental state
- A is oxidized, B is reduced
- Occurs because some elements are more stable in the elemental state than others.

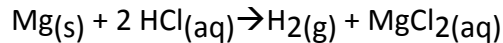


Activity Series

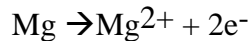
<u>Metal</u>	<u>Oxidation reaction</u>	
Potassium	$\text{K} \rightarrow \text{K}^+ + \text{e}^-$	most reactive/least stable
Sodium	$\text{Na} \rightarrow \text{Na}^+ + \text{e}^-$	
Magnesium	$\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^-$	
Aluminum	$\text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^-$	
Zinc	$\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$	
Iron	$\text{Fe} \rightarrow \text{Fe}^{2+} + 2\text{e}^-$	
Hydrogen	$\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$	

Copper	$\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$
Silver	$\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$
Mercury	$\text{Hg} \rightarrow \text{Hg}^{2+} + 2\text{e}^-$
Platinum	$\text{Pt} \rightarrow \text{Pt}^{2+} + 2\text{e}^-$
Gold	$\text{Au} \rightarrow \text{Au}^{3+} + 3\text{e}^-$ least reactive/most stable

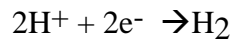
All metals above hydrogen will react with acids.



•Magnesium is being oxidized:



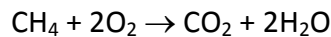
•Hydrogen is being reduced:



A reaction occurs when B is below A on the activity series.

Organic Reactions

- Oxidation: an increase in the number of bonds to oxygen or a decrease in the number of bonds to hydrogen.
- Reduction: an increase in the number of bonds to hydrogen or a decrease in the number of bonds to oxygen.



Aqueous Ionic Reactions

•Some key terms that are necessary when dealing with aqueous ionic reactions are:

- 1) A solution is a mixture in which one substance called the solute is uniformly dispersed in another substance called a solvent.
- 2) Solvation - the process of a solvent dissolving a solute.
- 3) Dissociation - where cation and anion separate from each other.
- 4) Spectator ions - ions that do not participate in a reaction.

Solubility Rules

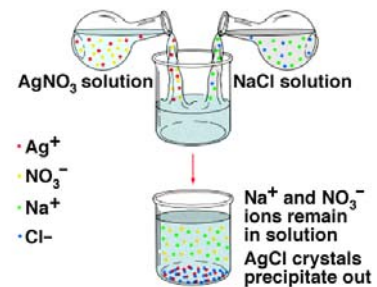
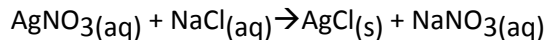
1. All compounds containing Na^+ , K^+ , or NH_4^+ ions are soluble in water.
2. All nitrates (NO_3^-) are soluble in water.

3. Most chlorides (Cl^-), and sulfates (SO_4^{2-}) are soluble. Some important exceptions are silver chloride (AgCl), barium sulfate (BaSO_4), and lead sulfate (PbSO_4) which are insoluble.

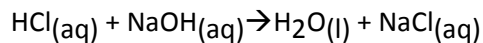
4. Most carbonates (CO_3^{2-}), phosphates (PO_4^{3-}), sulfides (S^{2-}), and hydroxides (OH^-) are insoluble in water. Important exceptions are those of Na^+ , K^+ , or NH_4^+ , as well as barium hydroxide, $\text{Ba}(\text{OH})_2$.

Double Replacement

- Pattern: $\text{AB} + \text{CD} \rightarrow \text{AD} + \text{CB}$
- Water is usually the solvent
- Basically the anions switch.
- Driving force is the formation of a solid (precipitation reactions), formation of water (acid base reactions) or formation of a gas.



Driving Force: Formation of a Solid



- Note that it is hard to see anything happening
- Traditionally we use an indicator to watch the disappearance of OH^- .
- This reaction also produces heat.

