Predicting Redox Reactions

* Metals lose electrons and form ions in redox reactions.
* The most reactive metals have the greatest tendency to lose electrons.
* Therefore the order of reactivity of metals is also the order of strength as reducing agents

The Spontaneity Rule

* A spontaneous reaction occurs only if the oxidizing agent (OA) is above the reducing agent (RA) in a table of relative strengths of oxidizing and reducing agents

Balancing Redox Reactions Using Oxidation Numbers

Example

* Write a balanced net ionic equation to show the combustion of ammonia in oxygen to produce nitrogen dioxide and water.

Solution

* Step 1: Write an unbalanced equation
    * $NH_3 + O_2 \rightarrow NO_2 + H_2O$

Solution

* Step 2: Assign Oxidation numbers to each element
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* $NH_3 + O_2 \rightarrow NO_2 + H_2O$

  -3 +1   0   +4 -2   +1 -2

Solution

* Step 3: Identify the changes in oxidation numbers as OXIDATION or REDUCTION

* $NH_3 + O_2 \longrightarrow NO_2 + H_2O$
  -3 +1 0 +4 -2 +1 -2
* OXIDATION: Nitrogen $NH_3 \longrightarrow NO_2 + 7e^-$

* REDUCTION: Oxygen $O_2 + 4e^- \longrightarrow NO_2$

Solution

* Step 4: Find the numerical value for the changes in oxidation number.
  * 1 nitrogen atom: changes from -3 to +4 $\longrightarrow$ increase of 7
  * 2 oxygen atoms: change from 0 to -2 $\longrightarrow$ decrease of 2 x 2atoms = total decrease of 4

Solution

* Step 5: Balance electron loss and gain by multiplying
* nitrogen: increase of 7 oxygen: decrease of 4
  * lowest common multiple = 28

Solution

Nitrogen: +7 x 4 = 28 $(NH_3 \rightarrow NO_2 + 7e^-) \times 4$

Oxygen: -4 x 7 = 28 $(O_2 + 4e^- \rightarrow NO_2) \times 7$

Electrons will cancel out

THEREFORE: $4\ NH_3 + 7\ O_2 \rightarrow NO_2 + H_2O$

Solution

* Step 6: Balance the other elements by inspection.

$$4\ NH_3 + 7\ O_2 \rightarrow 4\ NO_2 + 6\ H_2O$$

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* $B_2O_3 + Mg \rightarrow MgO + Mg_3B_2$

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* Balance the following reaction using the oxidation number method.

* $$\underset{+3\ \ -2}{B_2O_3} + \underset{0}{Mg} \rightarrow \underset{+2\ \ -2}{MgO} + \underset{+2\ \ -3}{Mg_3B_2}$$

Solution

* Balance the following reaction using the oxidation number method.

* B_2O_3 + Mg → MgO + Mg_3B_2
  +3 -2   0   +2 -2   +2 -3

RED: B_2O_3 + 12 e- → Mg_3B_2

OX: (Mg → MgO + 2e-) x6

Solution

* Balance the following reaction using the oxidation number method.

* B_2O_3 + Mg → MgO + Mg_3B_2
  +3 -2 0 +2 -2 +2 -3

RED: B_2O_3 + 12 e- → Mg_3B_2

OX: (Mg → MgO + 2e-) x6

B_2O_3 + 6 Mg → 3 MgO + Mg_3B_2