Redox Reactions

An introduction to Electrochemistry

Total Ionic Equation

* Represent ever ion in an equation individually.
* Example: $Na_{(s)} + Ag_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + Ag_{(s)}$
* Total Ionic Equation:
  * $Na_{(s)} + 2Ag^{1+}{}_{(aq)} + SO_4{}^{(2-)}{}_{(aq)} \rightarrow 2Na^{+1}{}_{(aq)} + SO_4{}^{(2-)}{}_{(aq)} + Ag_{(s)}$

Net Ionic Equation

* Only represent the ions that change from one side to another.
    * $Na_{(s)} + 2Ag^{1+}{}_{(aq)} + SO_4{}^{(2-)}{}_{(aq)} \rightarrow 2Na^{+1}{}_{(aq)} + SO_4{}^{(2-)}{}_{(aq)} + Ag_{(s)}$

Net Ionic Equation

* Only represent the ions that change from one side to another.
  * $Na_{(s)} + 2Ag^{1+}_{(aq)} + SO_4^{(2-)}_{(aq)} \rightarrow 2Na^{+1}_{(aq)} + SO_4^{(2-)}_{(aq)} + Ag_{(s)}$
  * $Na_{(s)} + 2Ag^{1+}_{(aq)} + \cancel{SO_4^{(2-)}}_{(aq)} \rightarrow 2Na^{+1}_{(aq)} + \cancel{SO_4^{(2-)}}_{(aq)} + Ag_{(s)}$
  * $Na_{(s)} + 2Ag^{1+}_{(aq)} \rightarrow 2Na^{+1}_{(aq)} + Ag_{(s)}$

Reduction

* A process in which chemical entities gain electrons
    * In the above reaction, Ag^{1+} becomes Ag, a gain of one electron

Oxidation

* A process in which chemical entities lose electrons.
* In the above reaction Na becomes Na^{1+}, a loss of one electron

Redox Reactions

* A reaction in which one reactant is oxidized and the other reactant is reduced.


GER
LEO

LEO the lion says GER

Loss of Electrons means Oxidation
Gain of Electrons means Reduction

Redox Reactions of Ionic Compounds

* Identify the reactants that are oxidized and reduced

$$Ca_{(s)} + Sn^{2+}{}_{(aq)} \longrightarrow Ca^{(2+)} + Sn_{(s)}$$

Redox Reactions of Ionic Compounds

* Identify the reactants that are oxidized and reduced

$$Ca_{(s)} + Sn^{2+}{}_{(aq)} \rightarrow Ca^{(2+)} + Sn_{(s)}$$

Loss of $2e^-$ Gain of $2e^-$

Therefore, calcium is being oxidized and tin is being reduced.

Redox Reactions of Ionic Compounds

* Identify the reactants that are oxidized and reduced

$$\overset{}{Zn_{(s)}} + S_{(s)} \rightarrow Zn^{2+}S^{2-}_{(s)}$$

2- 2+

$Zn_{(s)} + S_{(s)} \rightarrow ZnS_{(s)}$

Therefore, calcium is being oxidized and tin is being reduced.

Redox Reactions of Ionic Compounds

* Identify the reactants that are oxidized and reduced

$$Zn_{(s)} + S_{(s)} \rightarrow ZnS_{(s)}$$

Loss of $2e^-$ Gain of $2e^-$

Therefore, zinc is being oxidized and sulfur is being reduced.

Redox Reactions

Part II: Determining oxidation numbers

Redox Reactions of Nonmetals

* Unlike ionic compounds, covalent compounds share electrons rather than gain or lose.
* We must use oxidation numbers to show electron exchange.

Calculating Oxidation Numbers

* Let's look at oxygen
  * Must gain 2 electrons (2e-)
  * We assign oxygen an oxidation number of two.

Using Oxidation Numbers

* We know that the sum of all oxidation numbers in a neutral molecule must be zero.

Using Oxidation Numbers

- Example: $S_{(s)} + O_{2(g)} \rightarrow SO_{2(g)}$
- Determine the oxidation number of S in $SO_{2(g)}$

SO_2

S + 2(O)

We know that the oxidation number of oxygen is 2

Using Oxidation Numbers

- Example: $S_{(s)} + O_{2(g)} \rightarrow SO_{2(g)}$
- Determine the oxidation number of S in $SO_{2(g)}$

SO_2

$S + 2(-2) = 0$
$S + (-4) = 0$
$S = (+4)$

Therefore the oxidation number of sulfur in SO_2 is +4.

Using Oxidation Numbers

- Determine the oxidation number of N in $KNO_{3(s)}$

KNO_3

K + N + 3(0) =0

We know that the oxidation number of oxygen is -2 and the oxidation number for K is +1

Using Oxidation Numbers

* Determine the oxidation number of N in $KNO_{3(s)}$

KNO_3

$$K + N + 3(O) = 0$$
$$(+1) + (N) + 3(-2) = 0$$
$$1 + N - 6 = 0$$
$$-5 + N = 0$$
$$N = +5$$

Therefore the oxidation number of nitrogen in KNO_3 is +5.

Using Oxidation Numbers

* Determine the oxidation number of C in $CO_3^{2-}{}_{(g)}$

CO_3^{2-}

$C + 3(O) = -2$

We know that the oxidation number of oxygen is -2

Using Oxidation Numbers

* Determine the oxidation number of C in $CO_3^{2-}{}_{(g)}$

CO_3^{2-}

C + 3(0) = -2
C + 3(-2) -2
C - 6 = -2
C= +4

Therefore the oxidation number of C in CO_3^{2-} is +4.

Rules to Assigning Oxidation Numbers

* The oxidation number of an ion is the charge of that ion.
* The sum of all oxidation numbers in compound is always zero unless the compound itself carries a charge.