CHAPTER 08

REDOX REACTIONS-2

8. Water as an Oxidant and Reductant

Some oxidizing agents, such as fluorine, can oxidize water to oxygen. There are also some reducing agents, such as lithium, which can reduce water to hydrogen. Water is rather weak as an oxidizing or as a reducing agent, however there are not many substances which reduce or oxidize it. Thus it makes a good solvent for redox reactions.

Water act as a reducing agent in presence of fluorine. Fluorine acts as an oxidizing agent and oxidizes water to ozone or oxygen.

$3F_2+3H_2O \rightarrow 6HF+O_3$

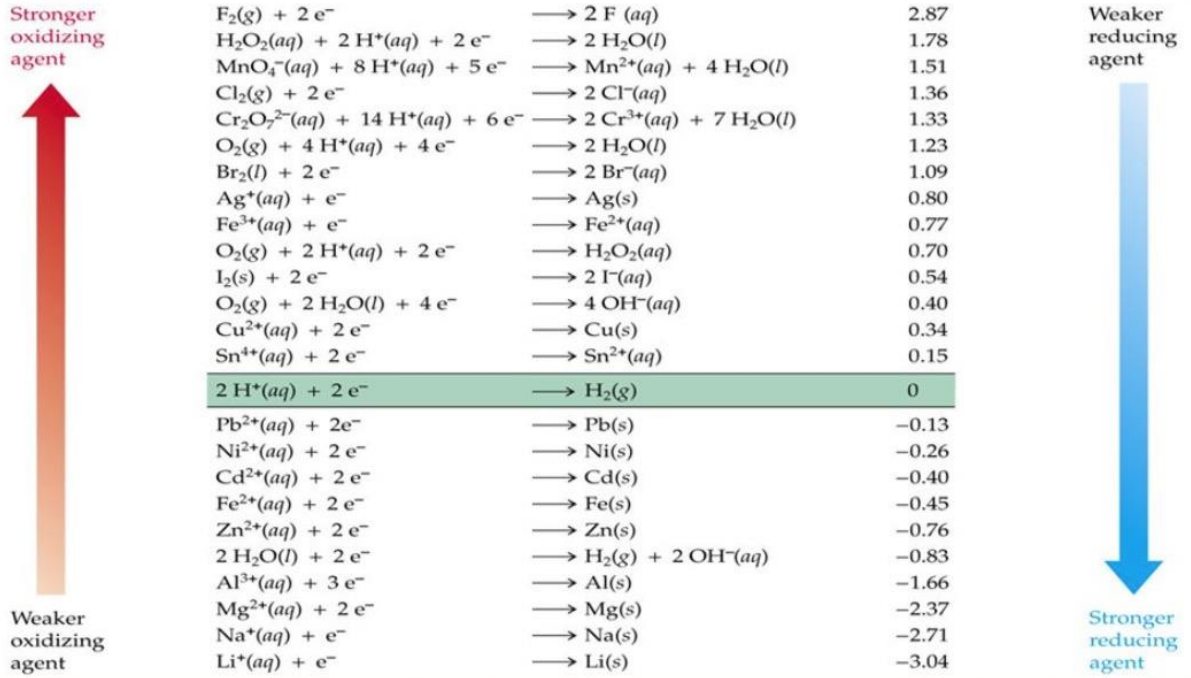
$2F_2+2H_2O \rightarrow 4HF+O_2$

Water act as an oxidizing agent in presence of lithium. Lithium acts as a reducing agent which reduces water to hydrogen.

$2Li+2H_2O \rightarrow 2LiOH+H_2$

9. Electrochemical Series

In electrochemical series, the electrodes (metals and non-metals) in contact with their ions are arranged on the basis of the values of their standard reduction or oxidation potentials. Standard electrode potential is obtained by measuring the voltage when the half -cell is connected to the standard hydrogen electrode under standard conditions.



$F_2(g) + 2\,e^-$	$\longrightarrow 2\,F\,(aq)$	2.87
$H_2O_2(aq) + 2\,H^+(aq) + 2\,e^-$	$\longrightarrow 2\,H_2O(l)$	1.78
$MnO_4^-(aq) + 8\,H^+(aq) + 5\,e^-$	$\longrightarrow Mn^{2+}(aq) + 4\,H_2O(l)$	1.51
$Cl_2(g) + 2\,e^-$	$\longrightarrow 2\,Cl^-(aq)$	1.36
$Cr_2O_7^{2-}(aq) + 14\,H^+(aq) + 6\,e^-$	$\longrightarrow 2\,Cr^{3+}(aq) + 7\,H_2O(l)$	1.33
$O_2(g) + 4\,H^+(aq) + 4\,e^-$	$\longrightarrow 2\,H_2O(l)$	1.23
$Br_2(l) + 2\,e^-$	$\longrightarrow 2\,Br^-(aq)$	1.09
$Ag^+(aq) + e^-$	$\longrightarrow Ag(s)$	0.80
$Fe^{3+}(aq) + e^-$	$\longrightarrow Fe^{2+}(aq)$	0.77
$O_2(g) + 2\,H^+(aq) + 2\,e^-$	$\longrightarrow H_2O_2(aq)$	0.70
$I_2(s) + 2\,e^-$	$\longrightarrow 2\,I^-(aq)$	0.54
$O_2(g) + 2\,H_2O(l) + 4\,e^-$	$\longrightarrow 4\,OH^-(aq)$	0.40
$Cu^{2+}(aq) + 2\,e^-$	$\longrightarrow Cu(s)$	0.34
$Sn^{4+}(aq) + 2\,e^-$	$\longrightarrow Sn^{2+}(aq)$	0.15
$2\,H^+(aq) + 2\,e^-$	$\longrightarrow H_2(g)$	0
$Pb^{2+}(aq) + 2e^-$	$\longrightarrow Pb(s)$	−0.13
$Ni^{2+}(aq) + 2\,e^-$	$\longrightarrow Ni(s)$	−0.26
$Cd^{2+}(aq) + 2\,e^-$	$\longrightarrow Cd(s)$	−0.40
$Fe^{2+}(aq) + 2\,e^-$	$\longrightarrow Fe(s)$	−0.45
$Zn^{2+}(aq) + 2\,e^-$	$\longrightarrow Zn(s)$	−0.76
$2\,H_2O(l) + 2\,e^-$	$\longrightarrow H_2(g) + 2\,OH^-(aq)$	−0.83
$Al^{3+}(aq) + 3\,e^-$	$\longrightarrow Al(s)$	−1.66
$Mg^{2+}(aq) + 2\,e^-$	$\longrightarrow Mg(s)$	−2.37
$Na^+(aq) + e^-$	$\longrightarrow Na(s)$	−2.71
$Li^+(aq) + e^-$	$\longrightarrow Li(s)$	−3.04

10. Application of Redox chemistry in Extraction of iron and aluminium from its ore

The redox reactions find a great deal of application in the extraction industry to extract metals or minerals from the natural ores. Metals usually exist in an oxidized state in nature (due to their long-term exposure to the oxygen present in the air surrounding them). Hence, they need to be reduced in order to extract the required metal out of them. This is done in the industry on a large scale with the help of a suitable reducing agent, depending on the metal or ore which is to be refined. For example, iron is extracted from the oxidized ore of ferric oxide in a large blast furnace in the iron extracting and refining industries using coke as a reducing agent.

The reaction takes of iron metal extraction from its oxidized natural ore takes place as follows:

$$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$$

Similarly, aluminium is extracted from its ore, aluminium oxide $Al(OH)_3$ by means of reduction. Other metals extracted in the same manner include magnesium, sodium, calcium, potassium, lithium, and many others.

$$4Al^{3+} + 12e^- \rightarrow 4Al$$

11.Combination reaction:

When two or more reactants react to form single product.
i.e a + b --> ab (in this single product is formed).
For the reaction to be Redox, both the elements should be in elemental form.
For example: All combustion reactions are Redox reactions.

$C + O_2 \text{ --------> } CO_2$
Carbon Oxygen Carbon dioxide

12.Decomposition reaction:

It is the type of reaction, in which a reactant breaks up into its constituents either by heating, passing current or in presence of light.