Standard Reduction Potentials

Having compared many reactions to the standard hydrogen potential, we can now make a table of reduction potentials for all half-reactions, (or oxidation potentials but we need to pick one and stick to it).

Below is an abbreviated table showing several half-reactions and their associated standard potentials. All "standard potentials" are reduction potentials unless told otherwise.

Half Reaction					potential
F_2	+	$2e^-$	$\rightleftharpoons$	$2F^-$	+2.87 V
Pb^{4+}	+	$2e^-$	$\rightleftharpoons$	Pb^{2+}	+1.67 V
Cl_2	+	$2e^-$	$\rightleftharpoons$	$2Cl^-$	+1.36 V
Ag^+	+	$1e^-$	$\rightleftharpoons$	Ag	+0.80 V
Fe^{3+}	+	$1e^-$	$\rightleftharpoons$	Fe^{2+}	+0.77 V
Cu^{2+}	+	$2e^-$	$\rightleftharpoons$	Cu	+0.34 V
$2H^+$	**+**	**$2e^-$**	$\rightleftharpoons$	**H_2**	**0.00 V**
Fe^{3+}	+	$3e^-$	$\rightleftharpoons$	Fe	−0.04 V
Pb^{2+}	+	$2e^-$	$\rightleftharpoons$	Pb	−0.13 V
Fe^{2+}	+	$2e^-$	$\rightleftharpoons$	Fe	−0.44 V
Zn^{2+}	+	$2e^-$	$\rightleftharpoons$	Zn	−0.76 V
Al^{3+}	+	$3e^-$	$\rightleftharpoons$	Al	−1.66 V
Mg^{2+}	+	$2e^-$	$\rightleftharpoons$	Mg	−2.36 V
Li^+	+	$1e^-$	$\rightleftharpoons$	Li	−3.05 V

increasing strength as an oxidizing agent

increasing strength as an reducing agent

Oxidizing Agents: At the top left of the table (where the green arrow is pointing) are the substances that are easiest to reduce. A better statement would be that those substances are ones that "want desperately" to be reduced, so much so that they will "forcefully" withdraw electrons from other species so that they can be reduced. This is the very definition of a good oxidizing agent. Fluorine gas is one of the best oxidizing agents there are and it is at the top of the table with the biggest most positive standard potential (+2.87 V).

Reducing Agents: At the other end, are reactions with negative standard potentials. This means that the desired path of the reaction is actually the *reverse* reaction. On the right side (product side) are substances that "want desperately" to lose their electrons and undergo an oxidation. These substances (ruled unsurprisingly by the alkali metals) will "force" their unwanted electrons upon other species. In doing so they become the definition of a powerful reducing agent. So the best reducing agents are at the bottom of the table on the right side and have the most negative standard potentials.

When looking at the table, we need to be careful since everything is written as a reduction. For example, from this table we can find the substance that is easiest to reduce. That is at the the top of the table (the $F_2/2F^-$ redox couple). ALL the substances on the left are being reduced but the reactions become less and less likely as the potential goes from positive to negative. Contrary to this are the substances that are being oxidized. ALL the species being oxidized are on the right side of the table (a product). Li(s) is obviously the easiest to oxidize because it is the extreme case of this situation.

> Look on the LEFT side of the half-reactions for substances that are going to be reduced. Look on the RIGHT side to find substances that are going to be oxidized.

Since Li is easy to oxidize, it is an excellent reducing agent (it reduces something else when it is oxidized). F_2 is a great oxidizing agent (it oxidizes something else when it is reduced).

From this table, we can now figure out what reactions will be spontaneous. For example, if something is higher in the table (higher standard potential) it will run in the forward direction and the active reactant will be reduced. The reactions that are lower on the table (more negative standard potentials) will tend to run in reverse (right to left) and the reaction will be an oxidation where the active species on the right (aka: the product) is being oxidized.

Will Ag^+ oxidize Fe? Yes. How do we know? The reduction potential for Ag^+ is more positive than that for Fe^{2+}. So Ag^+ is a strong enough oxidizing agent to oxidize Fe (look for it on the RIGHT side) to Fe^{2+}. On the other hand it could not oxidize chloride ions, Cl^-, to chlorine gas, Cl_2. Why? Because chlorine gas is a stronger oxidizing agent than silver ion.

Below is an image of our eBook's more extensive table of standard reduction potentials. You can find an even larger data set via the wikipedia link below the image.

Standard Potentials at 25°C

Half Reaction	Potential
$F_2 + 2e^- \rightarrow 2F^-$	+2.87 V
$O_3 + 2H^+ + 2e^- \rightarrow O_2 + H_2O$	+2.07 V
$S_2O_8^{2-} + 2e^- \rightarrow 2SO_4^{2-}$	+2.05 V
$PbO_2 + 4H^+ + SO_4^{2-} + 2e^- \rightarrow PbSO_4 + 2H_2O$	+1.69 V
$Au^+ + e^- \rightarrow Au$	+1.69 V
$Pb^{4+} + 2e^- \rightarrow Pb^{2+}$	+1.67 V
$2\ HClO + 2H^+ + 2e^- \rightarrow Cl_2 + 2H_2O$	+1.63 V
$Ce^{4+} + e^- \rightarrow Ce^{3+}$	+1.61 V
$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$	+1.51 V
$Au^{3+} + 3e^- \rightarrow Au$	+1.40 V
$Cl_2 + 2e^- \rightarrow 2Cl^-$	+1.36 V
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$	+1.33 V
$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$	+1.23 V
$MnO_2 + 4H^+ + 2e^- \rightarrow Mn^{2+} + 2H_2O$	+1.21 V
$Pt^{2+} + 2e^- \rightarrow Pt$	+1.20 V
$Br_2 + 2e^- \rightarrow 2Br^-$	+1.09 V
$2Hg^{2+} + 2e^- \rightarrow Hg_2^{2+}$	+0.92 V
$ClO^- + H_2O + 2e^- \rightarrow Cl^- + 2OH^-$	+0.89 V
$Ag^+ + e^- \rightarrow Ag$	+0.80 V
$Hg_2^{2+} + 2e^- \rightarrow 2Hg$	+0.79 V
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	+0.77 V
$MnO_4^- + 2H_2O + 3e^- \rightarrow MnO_2 + 4OH^-$	+0.60 V
$I_2 + 2e^- \rightarrow 2I^-$	+0.54 V
$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$	+0.40 V
$Cu^{2+} + 2e^- \rightarrow Cu$	+0.34 V
$Hg_2Cl_2 + 2e^- \rightarrow 2Hg + 2Cl^-$	+0.27 V
$AgCl + e^- \rightarrow Ag + Cl^-$	+0.22 V
$NO_3^- + H_2O + 2e^- \rightarrow NO_2^- + 2OH^-$	+0.01 V
$2H^+ + 2e^- \rightarrow H_2$	**0.000 V**

Half Reaction	Potential
$2H^+ + 2e^- \rightarrow H_2$	**0.000 V**
$Fe^{3+} + 3e^- \rightarrow Fe$	−0.04 V
$Pb^{2+} + 2e^- \rightarrow Pb$	−0.13 V
$Sn^{2+} + 2e^- \rightarrow Sn$	−0.14 V
$Ni^{2+} + 2e^- \rightarrow Ni$	−0.23 V
$V^{3+} + e^- \rightarrow V^{2+}$	−0.26 V
$Co^{2+} + 2e^- \rightarrow Co$	−0.28 V
$In^{3+} + 3e^- \rightarrow In$	−0.34 V
$PbSO_4 + 2e^- \rightarrow Pb + SO_4^{2-}$	−0.36 V
$Cd^{2+} + 2e^- \rightarrow Cd$	−0.40 V
$Cr^{3+} + e^- \rightarrow Cr^{2+}$	−0.41 V
$Fe^{2+} + 2e^- \rightarrow Fe$	−0.44 V
$Zn^{2+} + 2e^- \rightarrow Zn$	−0.76 V
$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$	−0.83 V
$Cr^{2+} + 2e^- \rightarrow Cr$	−0.91 V
$Mn^{2+} + 2e^- \rightarrow Mn$	−1.18 V
$V^{2+} + 2e^- \rightarrow V$	−1.19 V
$ZnS + 2e^- \rightarrow Zn + S^{2-}$	−1.44 V
$Al^{3+} + 3e^- \rightarrow Al$	−1.66 V
$Mg^{2+} + 2e^- \rightarrow Mg$	−2.36 V
$Na^+ + e^- \rightarrow Na$	−2.71 V
$K^+ + e^- \rightarrow K$	−2.92 V
$Li^+ + e^- \rightarrow Li$	−3.05 V

Note: all ions are aqueous (aq), many neutral species are solids (s), although some are liquids (l), gases (g), and even aqueous (aq). Use other sources for details on state. They were purposely left off here to save space and keep a cleaner looking table.

Here is a Link to our eBook's Standard Reduction Table.

External Resources

- http://en.wikipedia.org/w … ode_potential_(data_page) -

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