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Standard Reduction Potentials

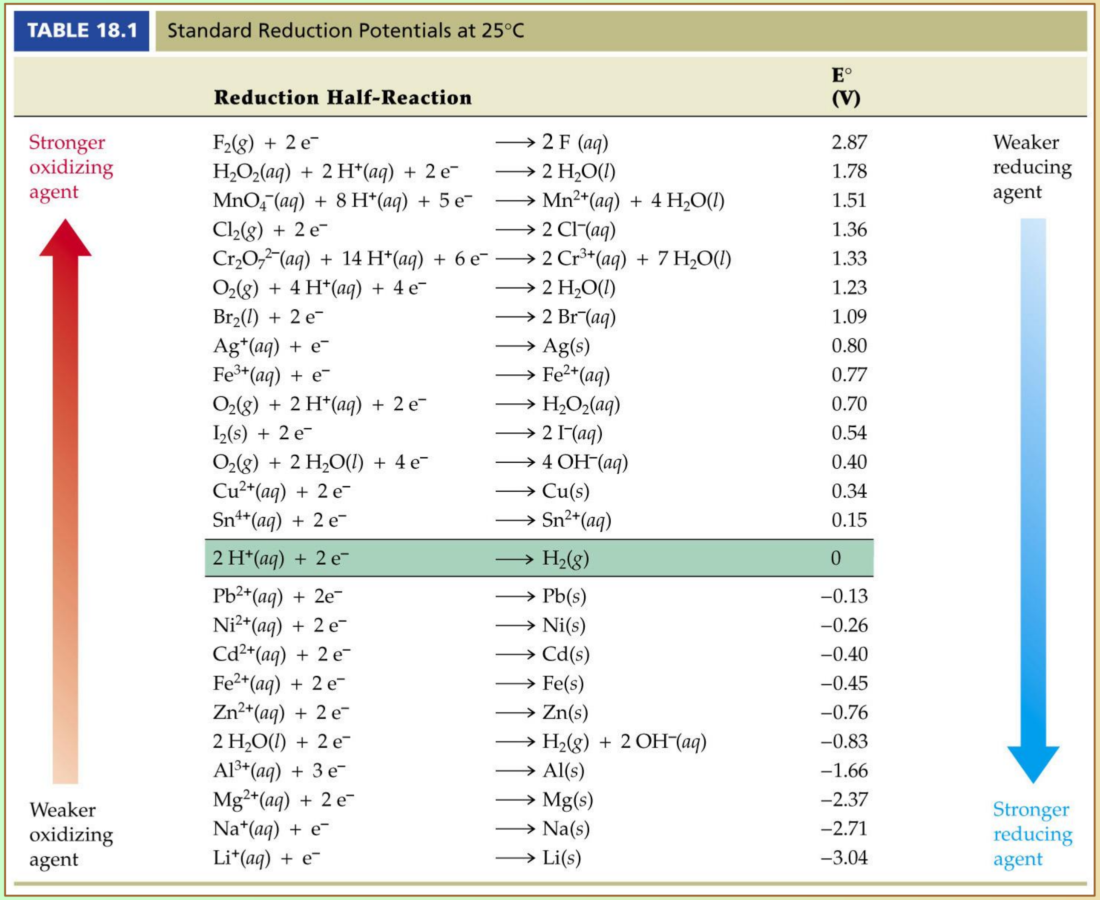

TABLE 18.1 Standard Reduction Potentials at 25°C

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

Reduction potentials

When a potential is assigned to a half-reaction, that half-reaction is written as a reduction and the potential is called standard reduction potential.

When stoichiometric coefficients are changed in a half-reaction, it does not affect the standard reduction potential. For example:

$$2\ Zn^{2+}\ (aq, 1M) + 4\ e^- \rightarrow 2\ Zn\ (s) \quad E^0_{red} = -0.76\ V$$

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Standard Reduction Potentials

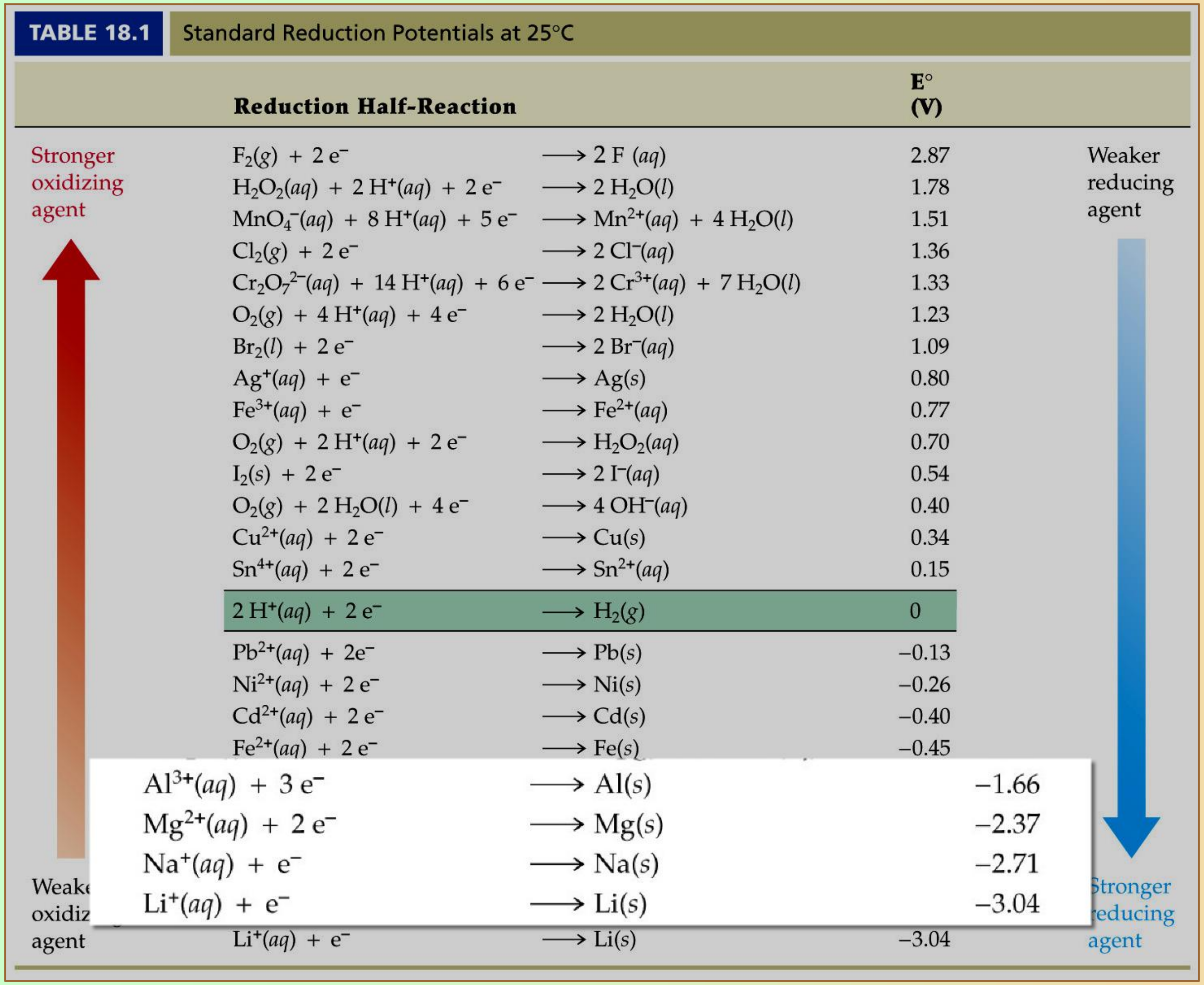

TABLE 18.1 Standard Reduction Potentials at 25°C

Stronger oxidizing agent

Weaker reducing agent

Reduction Half-Reaction		E° (V)
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$Cd^{2+}(aq) + 2e^-$	$\longrightarrow Cd(s)$	−0.40
$Fe^{2+}(aq) + 2e^-$	$\longrightarrow Fe(s)$	−0.45
$Li^+(aq) + e^-$	$\longrightarrow Li(s)$	−3.04

$Al^{3+}(aq) + 3e^-$	$\longrightarrow Al(s)$	−1.66
$Mg^{2+}(aq) + 2e^-$	$\longrightarrow Mg(s)$	−2.37
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Stronger reducing agent

Reducing agents

Lithium, the rest of alkalis and alkaline earth metals have a great tendency to transfer electrons to other species.

That means that their standard reduction potentials are highly negative.

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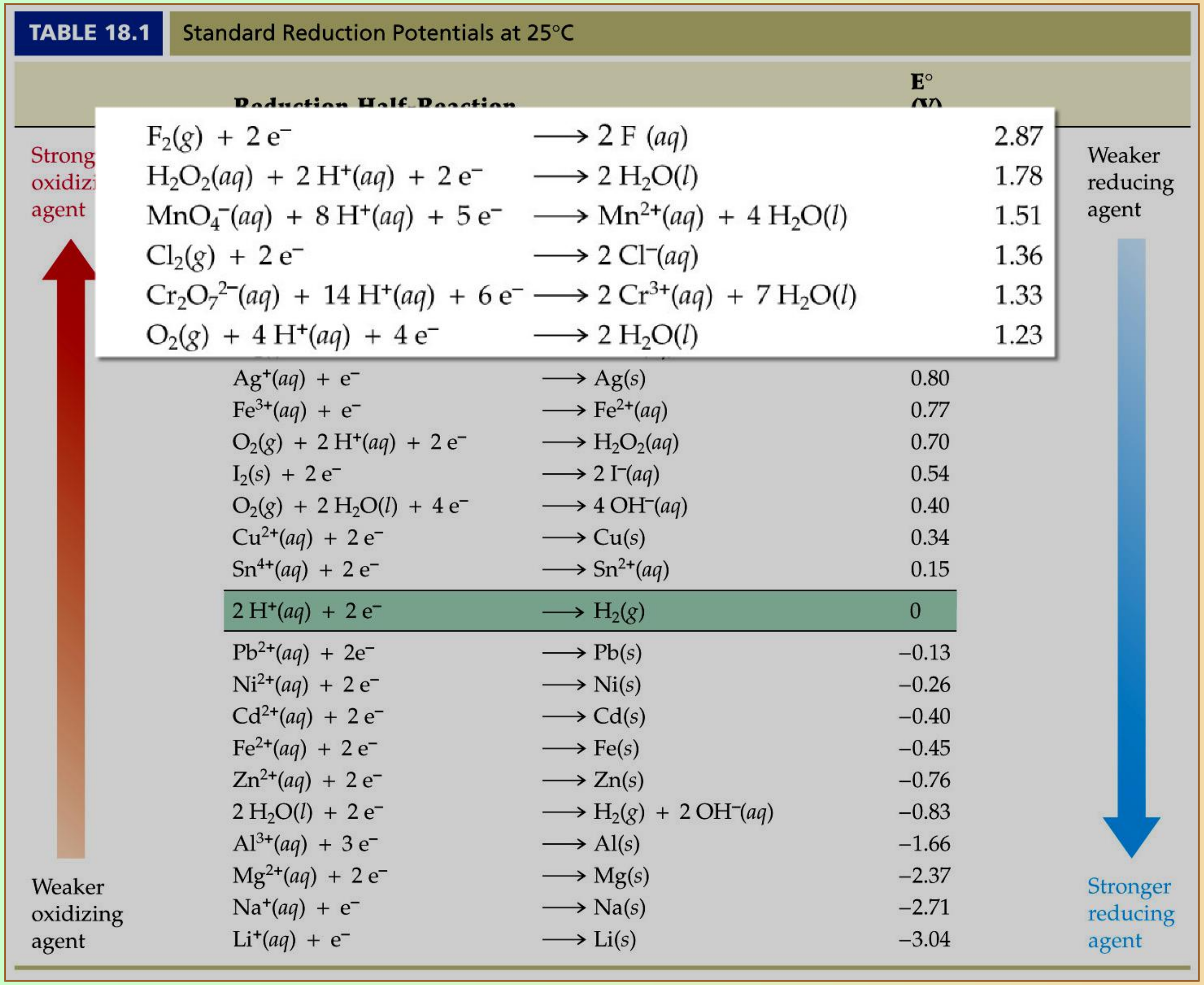
Standard Reduction Potentials



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$2\,H_2O(l) + 2\,e^-$	$\longrightarrow H_2(g) + 2\,OH^-(aq)$	−0.83
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Oxidizing agents

Fluorine, chlorine, permanganate, dichromate... are strong oxidizing agents.

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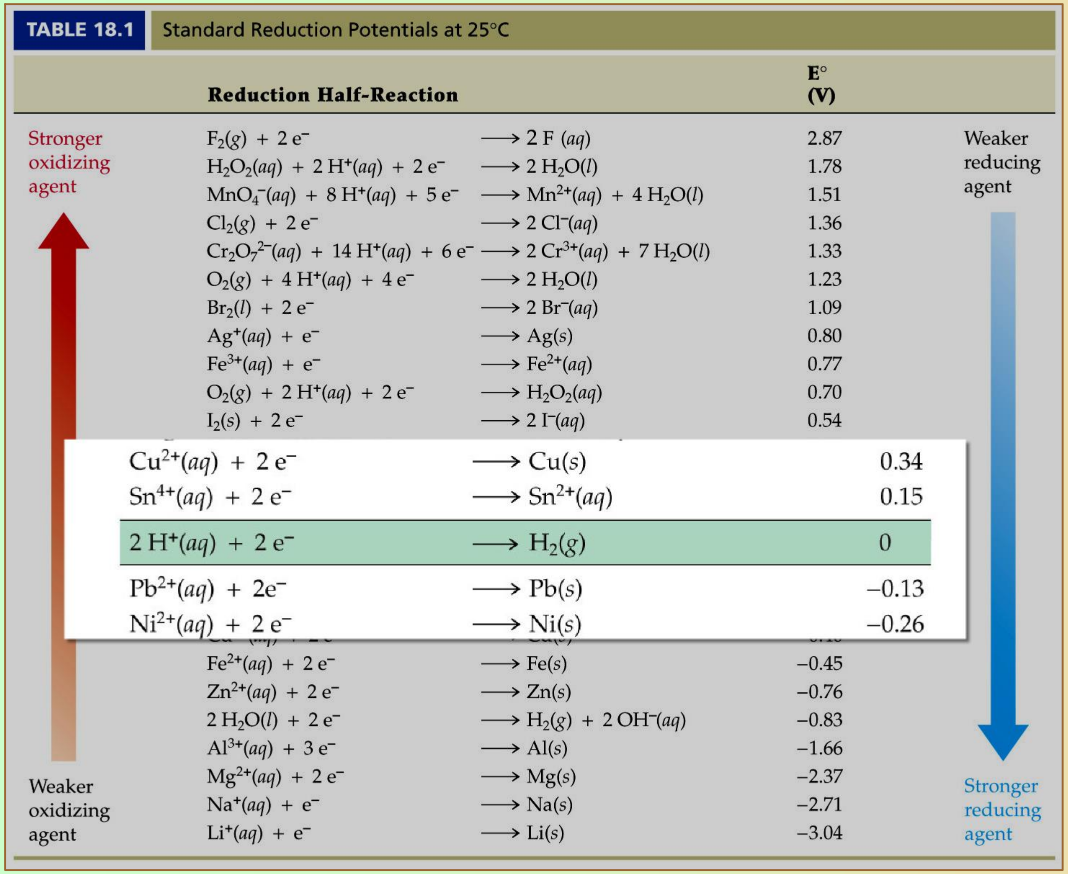
Standard Reduction Potentials



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Weaker oxidizing agent	$Mg^{2+}(aq) + 2\,e^-$	$\longrightarrow Mg(s)$	−2.37	Stronger reducing agent
	$Na^+(aq) + e^-$	$\longrightarrow Na(s)$	−2.71	
	$Li^+(aq) + e^-$	$\longrightarrow Li(s)$	−3.04	

Reference half-reaction

The reference half-reaction is the reduction of H^+ (aq) to H_2 (g) under standard conditions.

$$2\,H^+\ (aq, 1M) + 2\,e^- \rightarrow H_2\ (g, 1\ atm)\quad E^0 = 0\ V$$

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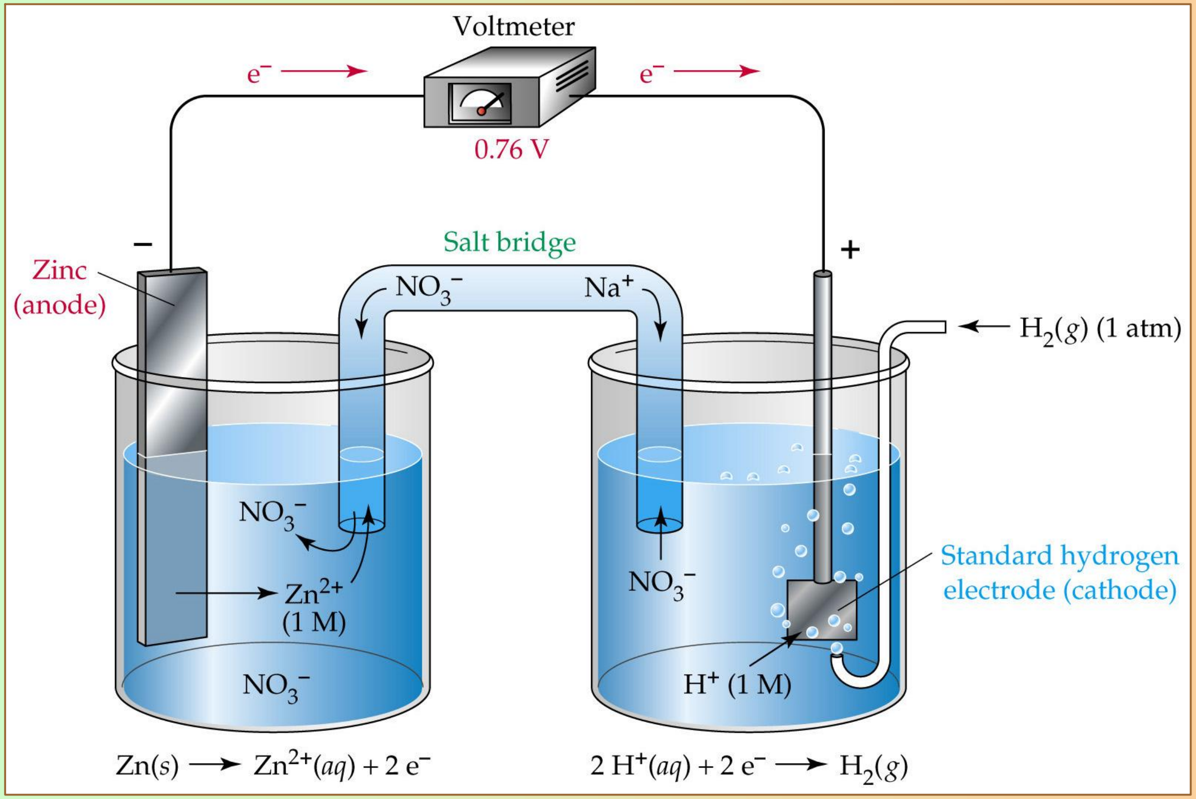
Reference half-reaction

An electrode designed to produce this half reaction is called a standard hydrogen electrode (SHE). This way, we can determine the standard reduction potentials for all the species.



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