

6.14: Standard Potential

Standard Potential

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Standard Electrode Potentials in Acidic Aqueous Solution (a table for basic solution is below)

at 25 °C.

Acidic Solution	Standard Electrode Potential, E° (volts)
$\text{F}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{F}^-(\text{aq})$	2.87
$\text{Co}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Co}^{2+}(\text{aq})$	1.92
$\text{Au}^+(\text{aq}) + \text{e}^- \rightarrow \text{Au}(\text{s})$	1.83
$\text{H}_2\text{O}_2(\text{aq}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow 2\text{H}_2\text{O}(\ell)$	1.763
$\text{Ce}^{4+}(\text{aq}) + \text{e}^- \rightarrow \text{Ce}^{3+}(\text{aq})$	1.72
$\text{Pb}^{4+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Pb}^{2+}(\text{aq})$	1.69
$\text{PbO}_2(\text{s}) + \text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O}(\ell)$	1.690
$\text{NiO}_2(\text{s}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{Ni}^{2+}(\text{aq}) + 2\text{H}_2\text{O}(\ell)$	1.68
$2\text{HClO}(\text{aq}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{Cl}_2(\text{g}) + 2\text{H}_2\text{O}(\ell)$	1.63
$\text{Au}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Au}(\text{s})$	1.52
$\text{MnO}_4^-(\text{aq}) + 8\text{H}^+(\text{aq}) + 5\text{e}^- \rightarrow \text{Mn}^{2+}(\text{aq}) + 4\text{H}_2\text{O}(\ell)$	1.51
$\text{BrO}_3^-(\text{aq}) + 6\text{H}^+(\text{aq}) + 5\text{e}^- \rightarrow 1/2\text{Br}_2(\text{aq}) + 3\text{H}_2\text{O}(\ell)$	1.478
$2\text{ClO}_3^-(\text{aq}) + 12\text{H}^+(\text{aq}) + 10\text{e}^- \rightarrow \text{Cl}_2(\text{g}) + 6\text{H}_2\text{O}(\ell)$	1.47
$\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^+(\text{aq}) + 6\text{e}^- \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\ell)$	1.36
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{Cl}^-(\text{aq})$	1.358
$\text{N}_2\text{H}_5^+(\text{aq}) + 3\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow 2\text{NH}_4^+(\text{aq})$	1.275
$\text{MnO}_2(\text{s}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{Mn}^{2+}(\text{aq}) + 2\text{H}_2\text{O}(\ell)$	1.23
$\text{O}_2(\text{g}) + 4\text{H}^+(\text{aq}) + 4\text{e}^- \rightarrow 2\text{H}_2\text{O}(\ell)$	1.229
$\text{ClO}_4^-(\text{aq}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{ClO}_3^-(\text{aq}) + \text{H}_2\text{O}(\ell)$	1.201
$\text{IO}_3^-(\text{aq}) + 6\text{H}^+(\text{aq}) + 5\text{e}^- \rightarrow 1/2\text{I}_2(\text{aq}) + 3\text{H}_2\text{O}(\ell)$	1.195
$\text{Pt}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Pt}(\text{s})$	1.188
$\text{Br}_2(\ell) + 2\text{e}^- \rightarrow 2\text{Br}^-(\text{aq})$	1.066
$[\text{AuCl}_4]^-(\text{aq}) + 3\text{e}^- \rightarrow \text{Au}(\text{s}) + 4\text{Cl}^-(\text{aq})$	1.00
$\text{NO}_3^-(\text{aq}) + 4\text{H}^+(\text{aq}) + 3\text{e}^- \rightarrow \text{NO}(\text{g}) + 2\text{H}_2\text{O}(\ell)$	0.96
$\text{NO}_3^-(\text{aq}) + 3\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{HNO}_2(\text{aq}) + \text{H}_2\text{O}(\ell)$	0.94
$\text{Pd}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Pd}(\text{s})$	0.915
$2\text{Hg}_2^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Hg}_2^{2+}(\text{aq})$	0.9110
$\text{Hg}_2^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Hg}(\ell)$	0.8535
$\text{SbCl}_6^-(\text{aq}) + 2\text{e}^- \rightarrow \text{SbCl}_4^-(\text{aq}) + 2\text{Cl}^-(\text{aq})$	0.84†
$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$	0.7991
$\text{Hg}_2^{2+}(\text{aq}) + 2\text{e}^- \rightarrow 2\text{Hg}(\ell)$	0.7960
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$	0.771
$[\text{PtCl}_4]^{2-}(\text{aq}) + 2\text{e}^- \rightarrow \text{Pt}(\text{s}) + 4\text{Cl}^-(\text{aq})$	0.758
$[\text{PtCl}_6]^{2-}(\text{aq}) + 2\text{e}^- \rightarrow [\text{PtCl}_4]^{2-}(\text{aq}) + 2\text{Cl}^-(\text{aq})$	0.726

Acidic Solution	Standard Electrode Potential, E° (volts)
$\text{O}_2(\text{g}) + 2 \text{H}^+(\text{aq}) + 2 \text{e}^- \rightarrow \text{H}_2\text{O}_2(\text{aq})$	0.695
$\text{TeO}_2(\text{s}) + 4 \text{H}^+(\text{aq}) + 4 \text{e}^- \rightarrow \text{Te}(\text{s}) + 2 \text{H}_2\text{O}(\ell)$	0.604
$\text{H}_3\text{AsO}_4(\text{aq}) + 2 \text{H}^+(\text{aq}) + 2 \text{e}^- \rightarrow \text{HAsO}_2(\text{aq}) + 2 \text{H}_2\text{O}(\ell)$	0.560
$\text{I}_2(\text{s}) + 2 \text{e}^- \rightarrow 2 \text{I}^-(\text{aq})$	0.535
$\text{Cu}^+(\text{aq}) + \text{e}^- \rightarrow \text{Cu}(\text{s})$	0.521
$[\text{RhCl}_6]^{3-}(\text{aq}) + 3 \text{e}^- \rightarrow \text{Rh}(\text{s}) + 6 \text{Cl}^-(\text{aq})$	0.5
$\text{Cu}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Cu}(\text{s})$	0.340
$\text{Hg}_2\text{Cl}_2(\text{s}) + 2 \text{e}^- \rightarrow 2 \text{Hg}(\ell) + 2 \text{Cl}^-(\text{aq})$	0.27
$\text{AgCl}(\text{s}) + \text{e}^- \rightarrow \text{Ag}(\text{s}) + \text{Cl}^-(\text{aq})$	0.222
$\text{Cu}^{2+}(\text{aq}) + \text{e}^- \rightarrow \text{Cu}^+(\text{aq})$	0.159
$\text{SO}_4^{2-}(\text{aq}) + 4 \text{H}^+(\text{aq}) + 2 \text{e}^- \rightarrow \text{H}_2\text{SO}_3(\text{aq}) + \text{H}_2\text{O}(\ell)$	0.158
$\text{Sn}^{4+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Sn}^{2+}(\text{aq})$	0.15
$\text{S}(\text{s}) + 2 \text{H}^+(\text{aq}) + 2 \text{e}^- \rightarrow \text{H}_2\text{S}(\text{aq})$	0.144
$\text{AgBr}(\text{s}) + \text{e}^- \rightarrow \text{Ag}(\text{s}) + \text{Br}^-(\text{aq})$	0.0713
$2 \text{H}^+(\text{aq}) + 2 \text{e}^- \rightarrow \text{H}_2(\text{g})$ (reference electrode)	0
$\text{N}_2\text{O}(\text{g}) + 6 \text{H}^+(\text{aq}) + \text{H}_2\text{O}(\ell) + 4 \text{e}^- \rightarrow 2 \text{NH}_3\text{OH}^+(\text{aq})$	-0.05
$\text{HgS}(\text{s, black}) + 2 \text{H}^+(\text{aq}) + 2 \text{e}^- \rightarrow \text{Hg}(\ell) + \text{H}_2\text{S}(\text{g})$	-0.085
$\text{Se}(\text{s}) + 2 \text{H}^+(\text{aq}) + 2 \text{e}^- \rightarrow \text{H}_2\text{Se}(\text{aq})$	-0.115
$\text{Pb}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Pb}(\text{s})$	-0.125
$\text{Sn}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Sn}(\text{s})$	-0.1375
$\text{AgI}(\text{s}) + \text{e}^- \rightarrow \text{Ag}(\text{s}) + \text{I}^-(\text{aq})$	-0.1522
$[\text{SnF}_6]^{2-}(\text{aq}) + 4 \text{e}^- \rightarrow \text{Sn}(\text{s}) + 6 \text{F}^-(\text{aq})$	-0.200
$\text{Ni}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Ni}(\text{s})$	-0.25
$\text{Co}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Co}(\text{s})$	-0.277
$\text{Tl}^+(\text{aq}) + \text{e}^- \rightarrow \text{Tl}(\text{s})$	-0.3363
$\text{PbSO}_4(\text{s}) + 2 \text{e}^- \rightarrow \text{Pb}(\text{s}) + \text{SO}_4^{2-}(\text{aq})$	-0.3505
$\text{Cd}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Cd}(\text{s})$	-0.403
$\text{Cr}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Cr}^{2+}(\text{aq})$	-0.424
$\text{Fe}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Fe}(\text{s})$	-0.44
$2 \text{CO}_2(\text{g}) + 2 \text{H}^+(\text{aq}) + 2 \text{e}^- \rightarrow (\text{COOH})_2(\text{aq})$	-0.481
$\text{TiO}_2(\text{s}) + 4 \text{H}^+(\text{aq}) + 2 \text{e}^- \rightarrow \text{Ti}^{2+}(\text{aq}) + 2 \text{H}_2\text{O}(\ell)$	-0.502
$\text{Ga}^{3+}(\text{aq}) + 3 \text{e}^- \rightarrow \text{Ga}(\text{s})$	-0.53
$\text{Cr}^{3+}(\text{aq}) + 3 \text{e}^- \rightarrow \text{Cr}(\text{s})$	-0.74
$\text{Zn}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Zn}(\text{s})$	-0.763
$\text{Cr}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Cr}(\text{s})$	-0.90
$\text{V}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{V}(\text{s})$	-1.13
$\text{Mn}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Mn}(\text{s})$	-1.18
$\text{Zr}^{4+}(\text{aq}) + 4 \text{e}^- \rightarrow \text{Zr}(\text{s})$	-1.55
$\text{Al}^{3+}(\text{aq}) + 3 \text{e}^- \rightarrow \text{Al}(\text{s})$	-1.676
$\text{H}_2(\text{g}) + 2 \text{e}^- \rightarrow 2 \text{H}^-(\text{aq})$	-2.25

Acidic Solution	Standard Electrode Potential, E° (volts)
$\text{Mg}^{2+}(\text{aq}) + 2 \text{e}^- \longrightarrow \text{Mg}(\text{s})$	-2.356
$\text{Na}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Na}(\text{s})$	-2.714
$\text{Ca}^{2+}(\text{aq}) + 2 \text{e}^- \longrightarrow \text{Ca}(\text{s})$	-2.84
$\text{Sr}^{2+}(\text{aq}) + 2 \text{e}^- \longrightarrow \text{Sr}(\text{s})$	-2.89
$\text{Ba}^{2+}(\text{aq}) + 2 \text{e}^- \longrightarrow \text{Ba}(\text{s})$	-2.92
$\text{Rb}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Rb}(\text{s})$	-2.925
$\text{K}^+(\text{aq}) + \text{e}^- \longrightarrow \text{K}(\text{s})$	-2.925
$\text{Li}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Li}(\text{s})$	-3.045

From Bard, A. J., Parsons, R., and Jordan, J., Standard Potentials in Aqueous Solution, New York: Marcel Dekker, 1985. International Union of Pure and Applied Chemistry, Commission on Electrochemistry and Electroanalytical Chemistry.

[†]From Brown, R. A., and Swift, E. H., Journal of the American Chemical Society, Vol. 71, 1949, pp. 2719-2723.

Standard Electrode Potentials in Basic Aqueous Solution

at 25 °C.

Basic Solution	Standard Electrode Potential, E° (volts)
$\text{ClO}^-(\text{aq}) + \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow \text{Cl}^-(\text{aq}) + 2 \text{OH}^-(\text{aq})$	0.89
$\text{OOH}^-(\text{aq}) + \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow 3 \text{OH}^-(\text{aq})$	0.867
$2 \text{NH}_2\text{OH}(\text{aq}) + 2 \text{e}^- \longrightarrow \text{N}_2\text{H}_4(\text{aq}) + 2 \text{OH}^-(\text{aq})$	0.73
$\text{ClO}_3^-(\text{aq}) + 3 \text{H}_2\text{O}(\ell) + 6 \text{e}^- \longrightarrow \text{Cl}^-(\text{aq}) + 6 \text{OH}^-(\text{aq})$	0.622
$\text{MnO}_4^-(\text{aq}) + 2 \text{H}_2\text{O}(\ell) + 3 \text{e}^- \longrightarrow \text{MnO}_2(\text{s}) + 4 \text{OH}^-(\text{aq})$	0.60
$\text{MnO}_4^-(\text{aq}) + \text{e}^- \longrightarrow \text{MnO}_4^{2-}(\text{aq})$	0.56
$\text{NiO}_2(\text{s}) + 2 \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow \text{Ni}(\text{OH})_2(\text{s}) + 2 \text{OH}^-(\text{aq})$	0.49
$\text{Ag}_2\text{CrO}_4(\text{s}) + 2 \text{e}^- \longrightarrow 2 \text{Ag}(\text{s}) + \text{CrO}_4^{2-}(\text{aq})$	0.4491
$\text{O}_2(\text{g}) + 2 \text{H}_2\text{O}(\ell) + 4 \text{e}^- \longrightarrow 4 \text{OH}^-(\text{aq})$	0.401
$\text{ClO}_4^-(\text{aq}) + \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow \text{ClO}_3^-(\text{aq}) + 2 \text{OH}^-(\text{aq})$	0.374
$\text{Ag}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow 2 \text{Ag}(\text{s}) + 2 \text{OH}^-(\text{aq})$	0.342
$2 \text{NO}_2^-(\text{aq}) + 3 \text{H}_2\text{O}(\ell) + 4 \text{e}^- \longrightarrow \text{N}_2\text{O}(\text{g}) + 6 \text{OH}^-(\text{aq})$	0.15
$\text{N}_2\text{H}_4(\text{aq}) + 2 \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow 2 \text{NH}_3(\text{aq}) + 2 \text{OH}^-(\text{aq})$	0.10
$\text{HgO}(\text{s}) + \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow \text{Hg}(\ell) + 2 \text{OH}^-(\text{aq})$	0.0977
$\text{O}_2(\text{g}) + \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow \text{OOH}^-(\text{aq}) + \text{OH}^-(\text{aq})$	0.0649
$[\text{Co}(\text{NH}_3)_6]^{3+}(\text{aq}) + \text{e}^- \longrightarrow [\text{Co}(\text{NH}_3)_6]^{2+}(\text{aq})$	0.058
$\text{NO}_3^-(\text{aq}) + \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow \text{NO}_2^-(\text{aq}) + 2 \text{OH}^-(\text{aq})$	0.01
$\text{MnO}_2(\text{s}) + 2 \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow \text{Mn}(\text{OH})_2(\text{s}) + 2 \text{OH}^-(\text{aq})$	-0.05
$\text{CrO}_4^{2-}(\text{aq}) + 4 \text{H}_2\text{O}(\ell) + 3 \text{e}^- \longrightarrow \text{Cr}(\text{OH})_3(\text{s}) + 5 \text{OH}^-(\text{aq})$	-0.11
$\text{Cu}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow 2 \text{Cu}(\text{s}) + 2 \text{OH}^-(\text{aq})$	-0.365
$\text{FeO}_2^-(\text{aq}) + \text{H}_2\text{O}(\ell) + \text{e}^- \longrightarrow \text{HFeO}_2^-(\text{aq}) + \text{OH}^-(\text{aq})$	-0.69
$\text{HFeO}_2^-(\text{aq}) + \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow \text{Fe}(\text{s}) + 3 \text{OH}^-(\text{aq})$	-0.8
$2 \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow \text{H}_2(\text{g}) + 2 \text{OH}^-(\text{aq})$	-0.8277
$2 \text{NO}_3^-(\text{aq}) + 2 \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow \text{N}_2\text{O}_4(\text{g}) + 4 \text{OH}^-(\text{aq})$	-0.86
$\text{SO}_4^{2-}(\text{aq}) + \text{H}_2\text{O}(\ell) + 2 \text{e}^- \longrightarrow \text{SO}_3^{2-}(\text{aq}) + 2 \text{OH}^-(\text{aq})$	-0.936
$\text{N}_2(\text{g}) + 4 \text{H}_2\text{O}(\ell) + 4 \text{e}^- \longrightarrow \text{N}_2\text{H}_4(\text{aq}) + 4 \text{OH}^-(\text{aq})$	-1.16

Basic Solution	Standard Electrode Potential, E° (volts)
$\text{Zn(OH)}_2(\text{s}) + 2 \text{e}^- \longrightarrow \text{Zn(s)} + 2 \text{OH}^-(\text{aq})$	-1.246
$[\text{Zn(OH)}_4]^{2-}(\text{aq}) + 2 \text{e}^- \longrightarrow \text{Zn(s)} + 4 \text{OH}^-(\text{aq})$	-1.285
$\text{Cr(OH)}_3(\text{s}) + 3 \text{e}^- \longrightarrow \text{Cr(s)} + 3 \text{OH}^-(\text{aq})$	-1.33
$[\text{Zn(CN)}_4]^{2-}(\text{aq}) + 2 \text{e}^- \longrightarrow \text{Zn(s)} + 4 \text{CN}^-(\text{aq})$	-1.34
$\text{SiO}_3^{2-}(\text{aq}) + 3 \text{H}_2\text{O}(\text{l}) + 4 \text{e}^- \longrightarrow \text{Si(s)} + 6 \text{OH}^-(\text{aq})$	-1.69

From Bard, A. J., Parsons, R., and Jordan, J., Standard Potentials in Aqueous Solution, New York: Marcel Dekker, 1985. International Union of Pure and Applied Chemistry, Commission on Electrochemistry and Electroanalytical Chemistry.

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