

APPENDIX H

Standard Reduction Potentials*

Reaction	E° (volts)	dE°/dT (mV/K)
Aluminum		
$\text{Al}^{3+} + 3e^- \rightleftharpoons \text{Al}(s)$	-1.677	0.533
$\text{AlCl}_2^+ + 3e^- \rightleftharpoons \text{Al}(s) + \text{Cl}^-$	-1.802	
$\text{AlF}_6^{3-} + 3e^- \rightleftharpoons \text{Al}(s) + 6\text{F}^-$	-2.069	
$\text{Al}(\text{OH})_4^- + 3e^- \rightleftharpoons \text{Al}(s) + 4\text{OH}^-$	-2.328	-1.13
Antimony		
$\text{SbO}^+ + 2\text{H}^+ + 3e^- \rightleftharpoons \text{Sb}(s) + \text{H}_2\text{O}$	0.208	
$\text{Sb}_2\text{O}_3(s) + 6\text{H}^+ + 6e^- \rightleftharpoons 2\text{Sb}(s) + 3\text{H}_2\text{O}$	0.147	-0.369
$\text{Sb}(s) + 3\text{H}^+ + 3e^- \rightleftharpoons \text{SbH}_3(g)$	-0.510	-0.030
Arsenic		
$\text{H}_3\text{AsO}_4 + 2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_3\text{AsO}_3 + \text{H}_2\text{O}$	0.575	-0.257
$\text{H}_3\text{AsO}_3 + 3\text{H}^+ + 3e^- \rightleftharpoons \text{As}(s) + 3\text{H}_2\text{O}$	0.247 5	-0.505
$\text{As}(s) + 3\text{H}^+ + 3e^- \rightleftharpoons \text{AsH}_3(g)$	-0.238	-0.029
Barium		
$\text{Ba}^{2+} + 2e^- + \text{Hg} \rightleftharpoons \text{Ba}(\text{in Hg})$	-1.717	
$\text{Ba}^{2+} + 2e^- \rightleftharpoons \text{Ba}(s)$	-2.906	-0.401
Beryllium		
$\text{Be}^{2+} + 2e^- \rightleftharpoons \text{Be}(s)$	-1.968	0.60
Bismuth		
$\text{Bi}^{3+} + 3e^- \rightleftharpoons \text{Bi}(s)$	0.308	0.18
$\text{BiCl}_4^- + 3e^- \rightleftharpoons \text{Bi}(s) + 4\text{Cl}^-$	0.16	
$\text{BiOCl}(s) + 2\text{H}^+ + 3e^- \rightleftharpoons \text{Bi}(s) + \text{H}_2\text{O} + \text{Cl}^-$	0.160	
Boron		
$2\text{B}(s) + 6\text{H}^+ + 6e^- \rightleftharpoons \text{B}_2\text{H}_6(g)$	-0.150	-0.296
$\text{B}_4\text{O}_7^{2-} + 14\text{H}^+ + 12e^- \rightleftharpoons 4\text{B}(s) + 7\text{H}_2\text{O}$	-0.792	
$\text{B}(\text{OH})_3 + 3\text{H}^+ + 3e^- \rightleftharpoons \text{B}(s) + 3\text{H}_2\text{O}$	-0.889	-0.492
Bromine		
$\text{BrO}_4^- + 2\text{H}^+ + 2e^- \rightleftharpoons \text{BrO}_3^- + \text{H}_2\text{O}$	1.745	-0.511
$\text{HOBr} + \text{H}^+ + e^- \rightleftharpoons \frac{1}{2}\text{Br}_2(l) + \text{H}_2\text{O}$	1.584	-0.75
$\text{BrO}_3^- + 6\text{H}^+ + 5e^- \rightleftharpoons \frac{1}{2}\text{Br}_2(l) + 3\text{H}_2\text{O}$	1.513	-0.419
$\text{Br}_2(aq) + 2e^- \rightleftharpoons 2\text{Br}^-$	1.098	-0.499
$\text{Br}_2(l) + 2e^- \rightleftharpoons 2\text{Br}^-$	1.078	-0.611
$\text{Br}_3^- + 2e^- \rightleftharpoons 3\text{Br}^-$	1.062	-0.512
$\text{BrO}^- + \text{H}_2\text{O} + 2e^- \rightleftharpoons \text{Br}^- + 2\text{OH}^-$	0.766	-0.94
$\text{BrO}_3^- + 3\text{H}_2\text{O} + 6e^- \rightleftharpoons \text{Br}^- + 6\text{OH}^-$	0.613	-1.287
Cadmium		
$\text{Cd}^{2+} + 2e^- + \text{Hg} \rightleftharpoons \text{Cd}(\text{in Hg})$	-0.380	
$\text{Cd}^{2+} + 2e^- \rightleftharpoons \text{Cd}(s)$	-0.402	-0.029
$\text{Cd}(\text{C}_2\text{O}_4)(s) + 2e^- \rightleftharpoons \text{Cd}(s) + \text{C}_2\text{O}_4^{2-}$	-0.522	
$\text{Cd}(\text{C}_2\text{O}_4)_2^{2-} + 2e^- \rightleftharpoons \text{Cd}(s) + 2\text{C}_2\text{O}_4^{2-}$	-0.572	
$\text{Cd}(\text{NH}_3)_4^{2+} + 2e^- \rightleftharpoons \text{Cd}(s) + 4\text{NH}_3$	-0.613	
$\text{CdS}(s) + 2e^- \rightleftharpoons \text{Cd}(s) + \text{S}^{2-}$	-1.175	
Calcium		
$\text{Ca}(s) + 2\text{H}^+ + 2e^- \rightleftharpoons \text{CaH}_2(s)$	0.776	
$\text{Ca}^{2+} + 2e^- + \text{Hg} \rightleftharpoons \text{Ca}(\text{in Hg})$	-2.003	
$\text{Ca}^{2+} + 2e^- \rightleftharpoons \text{Ca}(s)$	-2.868	-0.186

*All species are aqueous unless otherwise indicated. The reference state for amalgams is an infinitely dilute solution of the element in Hg. The temperature coefficient, dE°/dT , allows us to calculate the standard potential, $E^\circ(T)$, at temperature T : $E^\circ(T) = E^\circ + (dE^\circ/dT)\Delta T$, where ΔT is $T - 298.15$ K. Note the units mV/K for dE°/dT . Once you know E° for a net cell reaction at temperature T , you can find the equilibrium constant, K , for the reaction from the formula $K = 10^{nFE^\circ/RT \ln 10}$, where n is the number of electrons in each half-reaction, F is the Faraday constant, and R is the gas constant.

SOURCES: The most authoritative source is S. G. Bratsch, *J. Phys. Chem. Ref. Data* 1989, 18, 1. Additional data come from L. G. Sillen and A. E. Martell, *Stability Constants of Metal-Ion Complexes* (London: The Chemical Society, Special Publications Nos. 17 and 25, 1964 and 1971); G. Milazzo and S. Caroli, *Tables of Standard Electrode Potentials* (New York: Wiley, 1978); T. Mussini, P. Longhi, and S. Rondinini, *Pure Appl. Chem.* 1985, 57, 169. Another good source is A. J. Bard, R. Parsons, and J. Jordan, *Standard Potentials in Aqueous Solution* (New York: Marcel Dekker, 1985). Reduction potentials for 1 200 free radical reactions are given by P. Wardman, *J. Phys. Chem. Ref. Data* 1989, 18, 1637.

Reaction	E° (volts)	dE°/dT (mV/K)
$\text{Ca}(\text{acetate})^+ + 2e^- \rightleftharpoons \text{Ca}(s) + \text{acetate}^-$	-2.891	
$\text{CaSO}_4(s) + 2e^- \rightleftharpoons \text{Ca}(s) + \text{SO}_4^{2-}$	-2.936	
$\text{Ca}(\text{malonate})(s) + 2e^- \rightleftharpoons \text{Ca}(s) + \text{malonate}^{2-}$	-3.608	
Carbon		
$\text{C}_2\text{H}_2(g) + 2\text{H}^+ + 2e^- \rightleftharpoons \text{C}_2\text{H}_4(g)$	0.731	
$\text{O}=\text{C}_6\text{H}_4=\text{O} + 2\text{H}^+ + 2e^- \rightleftharpoons \text{HO}-\text{C}_6\text{H}_4-\text{OH}$	0.700	
$\text{CH}_3\text{OH} + 2\text{H}^+ + 2e^- \rightleftharpoons \text{CH}_4(g) + \text{H}_2\text{O}$	0.583	-0.039
Dehydroascorbic acid + $2\text{H}^+ + 2e^- \rightleftharpoons$ ascorbic acid + H_2O	0.390	
$(\text{CN})_2(g) + 2\text{H}^+ + 2e^- \rightleftharpoons 2\text{HCN}(aq)$	0.373	
$\text{H}_2\text{CO} + 2\text{H}^+ + 2e^- \rightleftharpoons \text{CH}_3\text{OH}$	0.237	-0.51
$\text{C}(s) + 4\text{H}^+ + 4e^- \rightleftharpoons \text{CH}_4(g)$	0.131 5	-0.209 2
$\text{HCO}_2\text{H} + 2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2\text{CO} + \text{H}_2\text{O}$	-0.029	-0.63
$\text{CO}_2(g) + 2\text{H}^+ + 2e^- \rightleftharpoons \text{CO}(g) + \text{H}_2\text{O}$	-0.103 8	-0.397 7
$\text{CO}_2(g) + 2\text{H}^+ + 2e^- \rightleftharpoons \text{HCO}_2\text{H}$	-0.114	-0.94
$2\text{CO}_2(g) + 2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2\text{C}_2\text{O}_4$	-0.432	-1.76
Cerium		
$\text{Ce}^{4+} + e^- \rightleftharpoons \text{Ce}^{3+}$	$\left\{ \begin{array}{l} 1.72 \\ 1.70 \text{ 1 F HClO}_4 \\ 1.44 \text{ 1 F H}_2\text{SO}_4 \\ 1.61 \text{ 1 F HNO}_3 \\ 1.47 \text{ 1 F HCl} \end{array} \right.$	1.54
$\text{Ce}^{3+} + 3e^- \rightleftharpoons \text{Ce}(s)$	-2.336	0.280
Cesium		
$\text{Cs}^+ + e^- + \text{Hg} \rightleftharpoons \text{Cs}(in \text{ Hg})$	-1.950	
$\text{Cs}^+ + e^- \rightleftharpoons \text{Cs}(s)$	-3.026	-1.172
Chlorine		
$\text{HClO}_2 + 2\text{H}^+ + 2e^- \rightleftharpoons \text{HOCl} + \text{H}_2\text{O}$	1.674	0.55
$\text{HClO} + \text{H}^+ + e^- \rightleftharpoons \frac{1}{2}\text{Cl}_2(g) + \text{H}_2\text{O}$	1.630	-0.27
$\text{ClO}_3^- + 6\text{H}^+ + 5e^- \rightleftharpoons \frac{1}{2}\text{Cl}_2(g) + 3\text{H}_2\text{O}$	1.458	-0.347
$\text{Cl}_2(aq) + 2e^- \rightleftharpoons 2\text{Cl}^-$	1.396	-0.72
$\text{Cl}_2(g) + 2e^- \rightleftharpoons 2\text{Cl}^-$	1.360 4	-1.248
$\text{ClO}_4^- + 2\text{H}^+ + 2e^- \rightleftharpoons \text{ClO}_3^- + \text{H}_2\text{O}$	1.226	-0.416
$\text{ClO}_3^- + 3\text{H}^+ + 2e^- \rightleftharpoons \text{HClO}_2 + \text{H}_2\text{O}$	1.157	-0.180
$\text{ClO}_3^- + 2\text{H}^+ + e^- \rightleftharpoons \text{ClO}_2 + \text{H}_2\text{O}$	1.130	0.074
$\text{ClO}_2 + e^- \rightleftharpoons \text{ClO}_2^-$	1.068	-1.335
Chromium		
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6e^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	1.36	-1.32
$\text{CrO}_4^{2-} + 4\text{H}_2\text{O} + 3e^- \rightleftharpoons \text{Cr}(\text{OH})_3(s, \text{hydrated}) + 5\text{OH}^-$	-0.12	-1.62
$\text{Cr}^{3+} + e^- \rightleftharpoons \text{Cr}^{2+}$	-0.42	1.4
$\text{Cr}^{3+} + 3e^- \rightleftharpoons \text{Cr}(s)$	-0.74	0.44
$\text{Cr}^{2+} + 2e^- \rightleftharpoons \text{Cr}(s)$	-0.89	-0.04
Cobalt		
$\text{Co}^{3+} + e^- \rightleftharpoons \text{Co}^{2+}$	$\left\{ \begin{array}{l} 1.92 \\ 1.817 \text{ 8 F H}_2\text{SO}_4 \\ 1.850 \text{ 4 F HNO}_3 \\ 0.37 \text{ 1 F NH}_4\text{NO}_3 \end{array} \right.$	1.23
$\text{Co}(\text{NH}_3)_5(\text{H}_2\text{O})^{3+} + e^- \rightleftharpoons \text{Co}(\text{NH}_3)_5(\text{H}_2\text{O})^{2+}$	0.1	
$\text{Co}(\text{NH}_3)_6^{3+} + e^- \rightleftharpoons \text{Co}(\text{NH}_3)_6^{2+}$	0.003	-0.04
$\text{CoOH}^+ + \text{H}^+ + 2e^- \rightleftharpoons \text{Co}(s) + \text{H}_2\text{O}$	-0.282	0.065
$\text{Co}^{2+} + 2e^- \rightleftharpoons \text{Co}(s)$	-0.746	-1.02
$\text{Co}(\text{OH})_2(s) + 2e^- \rightleftharpoons \text{Co}(s) + 2\text{OH}^-$		
Copper		
$\text{Cu}^+ + e^- \rightleftharpoons \text{Cu}(s)$	0.518	-0.754
$\text{Cu}^{2+} + 2e^- \rightleftharpoons \text{Cu}(s)$	0.339	0.011
$\text{Cu}^{2+} + e^- \rightleftharpoons \text{Cu}^+$	0.161	0.776
$\text{CuCl}(s) + e^- \rightleftharpoons \text{Cu}(s) + \text{Cl}^-$	0.137	
$\text{Cu}(\text{IO}_3)_2(s) + 2e^- \rightleftharpoons \text{Cu}(s) + 2\text{IO}_3^-$	-0.079	
$\text{Cu}(\text{ethylenediamine})_2^+ + e^- \rightleftharpoons \text{Cu}(s) + 2 \text{ ethylenediamine}$	-0.119	
$\text{CuI}(s) + e^- \rightleftharpoons \text{Cu}(s) + \text{I}^-$	-0.185	
$\text{Cu}(\text{EDTA})^{2-} + 2e^- \rightleftharpoons \text{Cu}(s) + \text{EDTA}^{4-}$	-0.216	
$\text{Cu}(\text{OH})_2(s) + 2e^- \rightleftharpoons \text{Cu}(s) + 2\text{OH}^-$	-0.222	
$\text{Cu}(\text{CN})_2 + e^- \rightleftharpoons \text{Cu}(s) + 2\text{CN}^-$	-0.429	
$\text{CuCN}(s) + e^- \rightleftharpoons \text{Cu}(s) + \text{CN}^-$	-0.639	

(Continued)

Reaction	E° (volts)	dE°/dT (mV/K)
Dysprosium		
$\text{Dy}^{3+} + 3\text{e}^- \rightleftharpoons \text{Dy}(s)$	-2.295	0.373
Erbium		
$\text{Er}^{3+} + 3\text{e}^- \rightleftharpoons \text{Er}(s)$	-2.331	0.388
Europium		
$\text{Eu}^{3+} + \text{e}^- \rightleftharpoons \text{Eu}^{2+}$	-0.35	1.53
$\text{Eu}^{3+} + 3\text{e}^- \rightleftharpoons \text{Eu}(s)$	-1.991	0.338
$\text{Eu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Eu}(s)$	-2.812	-0.26
Fluorine		
$\text{F}_2(g) + 2\text{e}^- \rightleftharpoons 2\text{F}^-$	2.890	-1.870
$\text{F}_2\text{O}(g) + 2\text{H}^+ + 4\text{e}^- \rightleftharpoons 2\text{F}^- + \text{H}_2\text{O}$	2.168	-1.208
Gadolinium		
$\text{Gd}^{3+} + 3\text{e}^- \rightleftharpoons \text{Gd}(s)$	-2.279	0.315
Gallium		
$\text{Ga}^{3+} + 3\text{e}^- \rightleftharpoons \text{Ga}(s)$	-0.549	0.61
$\text{GaOOH}(s) + \text{H}_2\text{O} + 3\text{e}^- \rightleftharpoons \text{Ga}(s) + 3\text{OH}^-$	-1.320	-1.08
Germanium		
$\text{Ge}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ge}(s)$	0.1	
$\text{H}_4\text{GeO}_4 + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{Ge}(s) + 4\text{H}_2\text{O}$	-0.039	-0.429
Gold		
$\text{Au}^+ + \text{e}^- \rightleftharpoons \text{Au}(s)$	1.69	-1.1
$\text{Au}^{3+} + 2\text{e}^- \rightleftharpoons \text{Au}^+$	1.41	
$\text{AuCl}_2^- + \text{e}^- \rightleftharpoons \text{Au}(s) + 2\text{Cl}^-$	1.154	
$\text{AuCl}_4^- + 2\text{e}^- \rightleftharpoons \text{AuCl}_2^- + 2\text{Cl}^-$	0.926	
Hafnium		
$\text{Hf}^{4+} + 4\text{e}^- \rightleftharpoons \text{Hf}(s)$	-1.55	0.68
$\text{HfO}_2(s) + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{Hf}(s) + 2\text{H}_2\text{O}$	-1.591	-0.355
Holmium		
$\text{Ho}^{3+} + 3\text{e}^- \rightleftharpoons \text{Ho}(s)$	-2.33	0.371
Hydrogen		
$2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2(g)$	0.000 0	0
$\text{H}_2\text{O} + \text{e}^- \rightleftharpoons \frac{1}{2}\text{H}_2(g) + \text{OH}^-$	-0.828 0	-0.836 0
Indium		
$\text{In}^{3+} + 3\text{e}^- + \text{Hg} \rightleftharpoons \text{In}(in\ Hg)$	-0.313	
$\text{In}^{3+} + 3\text{e}^- \rightleftharpoons \text{In}(s)$	-0.338	0.42
$\text{In}^{3+} + 2\text{e}^- \rightleftharpoons \text{In}^+$	-0.444	
$\text{In}(\text{OH})_3(s) + 3\text{e}^- \rightleftharpoons \text{In}(s) + 3\text{OH}^-$	-0.99	-0.95
Iodine		
$\text{IO}_4^- + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{IO}_3^- + \text{H}_2\text{O}$	1.589	-0.85
$\text{H}_5\text{IO}_6 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{HIO}_3 + 3\text{H}_2\text{O}$	1.567	-0.12
$\text{HOI} + \text{H}^+ + \text{e}^- \rightleftharpoons \frac{1}{2}\text{I}_2(s) + \text{H}_2\text{O}$	1.430	-0.339
$\text{ICl}_3(s) + 3\text{e}^- \rightleftharpoons \frac{1}{2}\text{I}_2(s) + 3\text{Cl}^-$	1.28	
$\text{ICl}(s) + \text{e}^- \rightleftharpoons \frac{1}{2}\text{I}_2(s) + \text{Cl}^-$	1.22	
$\text{IO}_3^- + 6\text{H}^+ + 5\text{e}^- \rightleftharpoons \frac{1}{2}\text{I}_2(s) + 3\text{H}_2\text{O}$	1.210	-0.367
$\text{IO}_3^- + 5\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{HOI} + 2\text{H}_2\text{O}$	1.154	-0.374
$\text{I}_2(aq) + 2\text{e}^- \rightleftharpoons 2\text{I}^-$	0.620	-0.234
$\text{I}_2(s) + 2\text{e}^- \rightleftharpoons 2\text{I}^-$	0.535	-0.125
$\text{I}_3^- + 2\text{e}^- \rightleftharpoons 3\text{I}^-$	0.535	-0.186
$\text{IO}_3^- + 3\text{H}_2\text{O} + 6\text{e}^- \rightleftharpoons \text{I}^- + 6\text{OH}^-$	0.269	-1.163
Iridium		
$\text{IrCl}_6^{2-} + \text{e}^- \rightleftharpoons \text{IrCl}_6^{3-}$	1.026	1 F HCl
$\text{IrBr}_6^{2-} + \text{e}^- \rightleftharpoons \text{IrBr}_6^{3-}$	0.947	2 F NaBr
$\text{IrCl}_6^{2-} + 4\text{e}^- \rightleftharpoons \text{Ir}(s) + 6\text{Cl}^-$	0.835	
$\text{IrO}_2(s) + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{Ir}(s) + 2\text{H}_2\text{O}$	0.73	
$\text{IrI}_6^{2-} + \text{e}^- \rightleftharpoons \text{IrI}_6^{3-}$	0.485	1 F KI
Iron		
$\text{Fe}(\text{phenanthroline})_3^{3+} + \text{e}^- \rightleftharpoons \text{Fe}(\text{phenanthroline})_3^{2+}$	1.147	
$\text{Fe}(\text{bipyridyl})_3^{3+} + \text{e}^- \rightleftharpoons \text{Fe}(\text{bipyridyl})_3^{2+}$	1.120	
$\text{FeOH}^{2+} + \text{H}^+ + \text{e}^- \rightleftharpoons \text{Fe}^{2+} + \text{H}_2\text{O}$	0.900	0.096
$\text{FeO}_4^{2-} + 3\text{H}_2\text{O} + 3\text{e}^- \rightleftharpoons \text{FeOOH}(s) + 5\text{OH}^-$	0.80	-1.59
$\text{Fe}^{3+} + \text{e}^- \rightleftharpoons \text{Fe}^{2+}$	0.771	1.175
	0.732	1 F HCl
	0.767	1 F HClO ₄
	0.746	1 F HNO ₃

Reaction	E° (volts)	dE°/dT (mV/K)
$\text{FeOOH}(s) + 3\text{H}^+ + e^- \rightleftharpoons \text{Fe}^{2+} + 2\text{H}_2\text{O}$	0.74	-1.05
Ferricinium ⁺ + e ⁻ ⇌ ferrocene	0.400	
$\text{Fe}(\text{CN})_6^{3-} + e^- \rightleftharpoons \text{Fe}(\text{CN})_6^{4-}$	0.356	
$\text{Fe}(\text{glutamate})^{3+} + e^- \rightleftharpoons \text{Fe}(\text{glutamate})^{2+}$	0.240	
$\text{FeOH}^+ + \text{H}^+ + 2e^- \rightleftharpoons \text{Fe}(s) + \text{H}_2\text{O}$	-0.16	0.07
$\text{Fe}^{2+} + 2e^- \rightleftharpoons \text{Fe}(s)$	-0.44	0.07
$\text{FeCO}_3(s) + 2e^- \rightleftharpoons \text{Fe}(s) + \text{CO}_3^{2-}$	-0.756	-1.293
Lanthanum		
$\text{La}^{3+} + 3e^- \rightleftharpoons \text{La}(s)$	-2.379	0.242
$\text{La}(\text{succinate})^+ + 3e^- \rightleftharpoons \text{La}(s) + \text{succinate}^{2-}$	-2.601	
Lead		
$\text{Pb}^{4+} + 2e^- \rightleftharpoons \text{Pb}^{2+}$	1.69	1 F HNO ₃
$\text{PbO}_2(s) + 4\text{H}^+ + \text{SO}_4^{2-} + 2e^- \rightleftharpoons \text{PbSO}_4(s) + 2\text{H}_2\text{O}$	1.685	
$\text{PbO}_2(s) + 4\text{H}^+ + 2e^- \rightleftharpoons \text{Pb}^{2+} + 2\text{H}_2\text{O}$	1.458	-0.253
$3\text{PbO}_2(s) + 2\text{H}_2\text{O} + 4e^- \rightleftharpoons \text{Pb}_3\text{O}_4(s) + 4\text{OH}^-$	0.269	-1.136
$\text{Pb}_3\text{O}_4(s) + \text{H}_2\text{O} + 2e^- \rightleftharpoons 3\text{PbO}(s, \text{red}) + 2\text{OH}^-$	0.224	-1.211
$\text{Pb}_3\text{O}_4(s) + \text{H}_2\text{O} + 2e^- \rightleftharpoons 3\text{PbO}(s, \text{yellow}) + 2\text{OH}^-$	0.207	-1.177
$\text{Pb}^{2+} + 2e^- \rightleftharpoons \text{Pb}(s)$	-0.126	-0.395
$\text{PbF}_2(s) + 2e^- \rightleftharpoons \text{Pb}(s) + 2\text{F}^-$	-0.350	
$\text{PbSO}_4(s) + 2e^- \rightleftharpoons \text{Pb}(s) + \text{SO}_4^{2-}$	-0.355	
Lithium		
$\text{Li}^+ + e^- + \text{Hg} \rightleftharpoons \text{Li}(\text{in Hg})$	-2.195	
$\text{Li}^+ + e^- \rightleftharpoons \text{Li}(s)$	-3.040	-0.514
Lutetium		
$\text{Lu}^{3+} + 3e^- \rightleftharpoons \text{Lu}(s)$	-2.28	0.412
Magnesium		
$\text{Mg}^{2+} + 2e^- + \text{Hg} \rightleftharpoons \text{Mg}(\text{in Hg})$	-1.980	
$\text{Mg}(\text{OH})^+ + \text{H}^+ + 2e^- \rightleftharpoons \text{Mg}(s) + \text{H}_2\text{O}$	-2.022	0.25
$\text{Mg}^{2+} + 2e^- \rightleftharpoons \text{Mg}(s)$	-2.360	0.199
$\text{Mg}(\text{C}_2\text{O}_4)(s) + 2e^- \rightleftharpoons \text{Mg}(s) + \text{C}_2\text{O}_4^{2-}$	-2.493	
$\text{Mg}(\text{OH})_2(s) + 2e^- \rightleftharpoons \text{Mg}(s) + 2\text{OH}^-$	-2.690	-0.946
Manganese		
$\text{MnO}_4^- + 4\text{H}^+ + 3e^- \rightleftharpoons \text{MnO}_2(s) + 2\text{H}_2\text{O}$	1.692	-0.671
$\text{Mn}^{3+} + e^- \rightleftharpoons \text{Mn}^{2+}$	1.56	1.8
$\text{MnO}_4^- + 8\text{H}^+ + 5e^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	1.507	-0.646
$\text{Mn}_2\text{O}_3(s) + 6\text{H}^+ + 2e^- \rightleftharpoons 2\text{Mn}^{2+} + 3\text{H}_2\text{O}$	1.485	-0.926
$\text{MnO}_2(s) + 4\text{H}^+ + 2e^- \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	1.230	-0.609
$\text{Mn}(\text{EDTA})^- + e^- \rightleftharpoons \text{Mn}(\text{EDTA})^{2-}$	0.825	-1.10
$\text{MnO}_4^- + e^- \rightleftharpoons \text{MnO}_4^{2-}$	0.56	-2.05
$3\text{Mn}_2\text{O}_3(s) + \text{H}_2\text{O} + 2e^- \rightleftharpoons 2\text{Mn}_3\text{O}_4(s) + 2\text{OH}^-$	0.002	-1.256
$\text{Mn}_3\text{O}_4(s) + 4\text{H}_2\text{O} + 2e^- \rightleftharpoons 3\text{Mn}(\text{OH})_2(s) + 2\text{OH}^-$	-0.352	-1.61
$\text{Mn}^{2+} + 2e^- \rightleftharpoons \text{Mn}(s)$	-1.182	-1.129
$\text{Mn}(\text{OH})_2(s) + 2e^- \rightleftharpoons \text{Mn}(s) + 2\text{OH}^-$	-1.565	-1.10
Mercury		
$2\text{Hg}^{2+} + 2e^- \rightleftharpoons \text{Hg}_2^{2+}$	0.908	0.095
$\text{Hg}^{2+} + 2e^- \rightleftharpoons \text{Hg}(l)$	0.852	-0.116
$\text{Hg}_2^{2+} + 2e^- \rightleftharpoons 2\text{Hg}(l)$	0.796	-0.327
$\text{Hg}_2\text{SO}_4(s) + 2e^- \rightleftharpoons 2\text{Hg}(l) + \text{SO}_4^{2-}$	0.614	
$\text{Hg}_2\text{Cl}_2(s) + 2e^- \rightleftharpoons 2\text{Hg}(l) + 2\text{Cl}^-$	0.268	
$\text{Hg}(\text{OH})_3^- + 2e^- \rightleftharpoons \text{Hg}(l) + 3\text{OH}^-$	0.231	
$\text{Hg}(\text{OH})_2 + 2e^- \rightleftharpoons \text{Hg}(l) + 2\text{OH}^-$	0.206	-1.24
$\text{Hg}_2\text{Br}_2(s) + 2e^- \rightleftharpoons 2\text{Hg}(l) + 2\text{Br}^-$	0.140	
$\text{HgO}(s, \text{yellow}) + \text{H}_2\text{O} + 2e^- \rightleftharpoons \text{Hg}(l) + 2\text{OH}^-$	0.098 3	-1.125
$\text{HgO}(s, \text{red}) + \text{H}_2\text{O} + 2e^- \rightleftharpoons \text{Hg}(l) + 2\text{OH}^-$	0.097 7	-1.120 6
Molybdenum		
$\text{MoO}_4^{2-} + 2\text{H}_2\text{O} + 2e^- \rightleftharpoons \text{MoO}_2(s) + 4\text{OH}^-$	-0.818	-1.69
$\text{MoO}_4^{2-} + 4\text{H}_2\text{O} + 6e^- \rightleftharpoons \text{Mo}(s) + 8\text{OH}^-$	-0.926	-1.36
$\text{MoO}_2(s) + 2\text{H}_2\text{O} + 4e^- \rightleftharpoons \text{Mo}(s) + 4\text{OH}^-$	-0.980	-1.196
Neodymium		
$\text{Nd}^{3+} + 3e^- \rightleftharpoons \text{Nd}(s)$	-2.323	0.282
Neptunium		
$\text{NpO}_3^+ + 2\text{H}^+ + e^- \rightleftharpoons \text{NpO}_2^+ + \text{H}_2\text{O}$	2.04	
$\text{NpO}_2^+ + e^- \rightleftharpoons \text{NpO}_2^+$	1.236	0.058

(Continued)

Reaction	E° (volts)	dE°/dT (mV/K)
$\text{NpO}_2^+ + 4\text{H}^+ + \text{e}^- \rightleftharpoons \text{Np}^{4+} + 2\text{H}_2\text{O}$		
$\text{Np}^{4+} + \text{e}^- \rightleftharpoons \text{Np}^{3+}$	0.567	-3.30
$\text{Np}^{3+} + 3\text{e}^- \rightleftharpoons \text{Np}(s)$	0.157	1.53
	-1.768	0.18
Nickel		
$\text{NiOOH}(s) + 3\text{H}^+ + \text{e}^- \rightleftharpoons \text{Ni}^{2+} + 2\text{H}_2\text{O}$		
$\text{Ni}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ni}(s)$	2.05	-1.17
$\text{Ni}(\text{CN})_4^{2-} + \text{e}^- \rightleftharpoons \text{Ni}(\text{CN})_3^- + \text{CN}^-$	-0.236	0.146
$\text{Ni}(\text{OH})_2(s) + 2\text{e}^- \rightleftharpoons \text{Ni}(s) + 2\text{OH}^-$	-0.401	
	-0.714	-1.02
Niobium		
$\frac{1}{2}\text{Nb}_2\text{O}_5(s) + \text{H}^+ + \text{e}^- \rightleftharpoons \text{NbO}_2(s) + \frac{1}{2}\text{H}_2\text{O}$		
$\frac{1}{2}\text{Nb}_2\text{O}_5(s) + 5\text{H}^+ + 5\text{e}^- \rightleftharpoons \text{Nb}(s) + \frac{5}{2}\text{H}_2\text{O}$	-0.248	-0.460
$\text{NbO}_2(s) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{NbO}(s) + \text{H}_2\text{O}$	-0.601	-0.381
$\text{NbO}_2(s) + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{Nb}(s) + 2\text{H}_2\text{O}$	-0.646	-0.347
	-0.690	-0.361
Nitrogen		
$\text{HN}_3 + 3\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{N}_2(g) + \text{NH}_4^+$		
$\text{N}_2\text{O}(g) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{N}_2(g) + \text{H}_2\text{O}$	2.079	0.147
$2\text{NO}(g) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{N}_2\text{O}(g) + \text{H}_2\text{O}$	1.769	-0.461
$\text{NO}^+ + \text{e}^- \rightleftharpoons \text{NO}(g)$	1.587	-1.359
$2\text{NH}_3\text{OH}^+ + \text{H}^+ + 2\text{e}^- \rightleftharpoons \text{N}_2\text{H}_5^+ + 2\text{H}_2\text{O}$	1.46	
$\text{NH}_3\text{OH}^+ + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{NH}_4^+ + \text{H}_2\text{O}$	1.40	-0.60
$\text{N}_2\text{H}_5^+ + 3\text{H}^+ + 2\text{e}^- \rightleftharpoons 2\text{NH}_4^+$	1.33	-0.44
$\text{HNO}_2 + \text{H}^+ + \text{e}^- \rightleftharpoons \text{NO}(g) + \text{H}_2\text{O}$	1.250	-0.28
$\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^- \rightleftharpoons \text{NO}(g) + 2\text{H}_2\text{O}$	0.984	0.649
$\text{NO}_3^- + 3\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{HNO}_2 + \text{H}_2\text{O}$	0.955	0.028
$\text{NO}_3^- + 2\text{H}^+ + \text{e}^- \rightleftharpoons \frac{1}{2}\text{N}_2\text{O}_4(g) + \text{H}_2\text{O}$	0.940	-0.282
$\text{N}_2(g) + 8\text{H}^+ + 6\text{e}^- \rightleftharpoons 2\text{NH}_4^+$	0.798	0.107
$\text{N}_2(g) + 5\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{N}_2\text{H}_5^+$	0.274	-0.616
$\text{N}_2(g) + 2\text{H}_2\text{O} + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons 2\text{NH}_3\text{OH}^+$	-0.214	-0.78
$\frac{1}{2}\text{N}_2(g) + \text{H}^+ + \text{e}^- \rightleftharpoons \text{HN}_3$	-1.83	-0.96
	-3.334	-2.141
Osmium		
$\text{OsO}_4(s) + 8\text{H}^+ + 8\text{e}^- \rightleftharpoons \text{Os}(s) + 4\text{H}_2\text{O}$		
$\text{OsCl}_6^{2-} + \text{e}^- \rightleftharpoons \text{OsCl}_5^-$	0.834	
	0.85	-0.458
		1 F HCl
Oxygen		
$\text{OH} + \text{H}^+ + \text{e}^- \rightleftharpoons \text{H}_2\text{O}$		
$\text{O}(g) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}$	2.56	
$\text{O}_3(g) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{O}_2(g) + \text{H}_2\text{O}$	2.430	-1.0
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	2.075	-1.148
$\text{HO}_2 + \text{H}^+ + \text{e}^- \rightleftharpoons \text{H}_2\text{O}_2$	1.763	-0.489
$\frac{1}{2}\text{O}_2(g) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}$	1.44	-0.698
$\text{O}_2(g) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}_2$	1.229	-0.7
$\text{O}_2(g) + \text{H}^+ + \text{e}^- \rightleftharpoons \text{HO}_2$	0.695	-0.845
	-0.05	-0.993
		-1.3
Palladium		
$\text{Pd}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pd}(s)$		
$\text{PdO}(s) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{Pd}(s) + \text{H}_2\text{O}$	0.915	0.12
$\text{PdCl}_4^{2-} + 2\text{e}^- \rightleftharpoons \text{Pd}(s) + 6\text{Cl}^-$	0.79	-0.33
$\text{PdO}_2(s) + \text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{PdO}(s) + 2\text{OH}^-$	0.615	
	0.64	-1.2
Phosphorus		
$\frac{1}{4}\text{P}_4(s, \text{white}) + 3\text{H}^+ + 3\text{e}^- \rightleftharpoons \text{PH}_3(g)$		
$\frac{1}{4}\text{P}_4(s, \text{red}) + 3\text{H}^+ + 3\text{e}^- \rightleftharpoons \text{PH}_3(g)$	-0.046	-0.093
$\text{H}_3\text{PO}_4 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_3\text{PO}_3 + \text{H}_2\text{O}$	-0.088	-0.030
$\text{H}_3\text{PO}_4 + 5\text{H}^+ + 5\text{e}^- \rightleftharpoons \frac{1}{4}\text{P}_4(s, \text{white}) + 4\text{H}_2\text{O}$	-0.30	-0.36
$\text{H}_3\text{PO}_3 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_3\text{PO}_2 + \text{H}_2\text{O}$	-0.402	-0.340
$\text{H}_3\text{PO}_2 + \text{H}^+ + \text{e}^- \rightleftharpoons \frac{1}{4}\text{P}_4(s) + 2\text{H}_2\text{O}$	-0.48	-0.37
	-0.51	
Platinum		
$\text{Pt}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pt}(s)$		
$\text{PtO}_2(s) + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{Pt}(s) + 2\text{H}_2\text{O}$	1.18	-0.05
$\text{PtCl}_4^{2-} + 2\text{e}^- \rightleftharpoons \text{Pt}(s) + 4\text{Cl}^-$	0.92	-0.36
$\text{PtCl}_6^{2-} + 2\text{e}^- \rightleftharpoons \text{PtCl}_4^{2-} + 2\text{Cl}^-$	0.755	
	0.68	
Plutonium		
$\text{PuO}_2^+ + \text{e}^- \rightleftharpoons \text{PuO}_2(s)$		
$\text{PuO}_2^+ + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{Pu}^{4+} + 2\text{H}_2\text{O}$	1.585	0.39
$\text{Pu}^{4+} + \text{e}^- \rightleftharpoons \text{Pu}^{3+}$	1.000	-1.615
$\text{PuO}_2^+ + \text{e}^- \rightleftharpoons \text{PuO}_2^+$	1.006	1.441
$\text{PuO}_2(s) + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{Pu}(s) + 2\text{H}_2\text{O}$	0.966	0.03
$\text{Pu}^{3+} + 3\text{e}^- \rightleftharpoons \text{Pu}(s)$	-1.369	-0.38
	-1.978	0.23

Reaction	E° (volts)	dE°/dT (mV/K)
potassium		
$K^+ + e^- + Hg \rightleftharpoons K(in\ Hg)$	-1.975	
$K^+ + e^- \rightleftharpoons K(s)$	-2.936	-1.074
praseodymium		
$Pr^{4+} + e^- \rightleftharpoons Pr^{3+}$	3.2	1.4
$Pr^{3+} + 3e^- \rightleftharpoons Pr(s)$	-2.353	0.291
promethium		
$Pm^{3+} + 3e^- \rightleftharpoons Pm(s)$	-2.30	0.29
radium		
$Ra^{2+} + 2e^- \rightleftharpoons Ra(s)$	-2.80	-0.44
reinerium		
$ReO_4^- + 2H^+ + e^- \rightleftharpoons ReO_3(s) + H_2O$	0.72	-1.17
$ReO_4^- + 4H^+ + 3e^- \rightleftharpoons ReO_2(s) + 2H_2O$	0.510	-0.70
rhodium		
$Rh^{6+} + 3e^- \rightleftharpoons Rh^{3+}$	1.48	1 F HClO ₄
$Rh^{4+} + e^- \rightleftharpoons Rh^{3+}$	1.44	3 F H ₂ SO ₄
$RhCl_6^{3-} + e^- \rightleftharpoons RhCl_6^{2-}$	1.2	
$Rh^{3+} + 3e^- \rightleftharpoons Rh(s)$	0.76	0.4
$2Rh^{3+} + 2e^- \rightleftharpoons Rh_2^{4+}$	0.7	
$RhCl_6^{3-} + 3e^- \rightleftharpoons Rh(s) + 6Cl^-$	0.44	
rubidium		
$Rb^+ + e^- + Hg \rightleftharpoons Rb(in\ Hg)$	-1.970	
$Rb^+ + e^- \rightleftharpoons Rb(s)$	-2.943	-1.140
ruthenium		
$RuO_4^- + 6H^+ + 3e^- \rightleftharpoons Ru(OH)_2^{2+} + 2H_2O$	1.53	
$Ru(dipyridyl)_3^{3+} + e^- \rightleftharpoons Ru(dipyridyl)_3^{2+}$	1.29	
$RuO_4(s) + 8H^+ + 8e^- \rightleftharpoons Ru(s) + 4H_2O$	1.032	-0.467
$Ru^{2+} + 2e^- \rightleftharpoons Ru(s)$	0.8	
$Ru^{3+} + 3e^- \rightleftharpoons Ru(s)$	0.60	
$Ru^{3+} + e^- \rightleftharpoons Ru^{2+}$	0.24	
$Ru(NH_3)_6^{3+} + e^- \rightleftharpoons Ru(NH_3)_6^{2+}$	0.214	
samarium		
$Sm^{3+} + 3e^- \rightleftharpoons Sm(s)$	-2.304	0.279
$Sm^{2+} + 2e^- \rightleftharpoons Sm(s)$	-2.68	-0.28
scandium		
$Sc^{3+} + 3e^- \rightleftharpoons Sc(s)$	-2.09	0.41
 selenium		
$SeO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons H_2SeO_3 + H_2O$	1.150	0.483
$H_2SeO_3 + 4H^+ + 4e^- \rightleftharpoons Se(s) + 3H_2O$	0.739	-0.562
$Se(s) + 2H^+ + 2e^- \rightleftharpoons H_2Se(g)$	-0.082	0.238
$Se(s) + 2e^- \rightleftharpoons Se^{2-}$	-0.67	-1.2
silicon		
$Si(s) + 4H^+ + 4e^- \rightleftharpoons SiH_4(g)$	-0.147	-0.196
$SiO_2(s, quartz) + 4H^+ + 4e^- \rightleftharpoons Si(s) + 2H_2O$	-0.990	-0.374
$SiF_6^{2-} + 4e^- \rightleftharpoons Si(s) + 6F^-$	-1.24	
silver		
$Ag^{2+} + e^- \rightleftharpoons Ag^+$	{ 2.000 4 F HClO ₄ 1.989 1.929 4 F HNO ₃	0.99
$Ag^{3+} + 2e^- \rightleftharpoons Ag^+$	1.9	
$AgO(s) + H^+ + e^- \rightleftharpoons \frac{1}{2}Ag_2O(s) + \frac{1}{2}H_2O$	1.40	
$Ag^+ + e^- \rightleftharpoons Ag(s)$	0.799 3	-0.989
$Ag_2C_2O_4(s) + 2e^- \rightleftharpoons 2Ag(s) + C_2O_4^{2-}$	0.465	
$AgN_3(s) + e^- \rightleftharpoons Ag(s) + N_3^-$	0.293	
$AgCl(s) + e^- \rightleftharpoons Ag(s) + Cl^-$	{ 0.222 0.197 saturated KCl	
$AgBr(s) + e^- \rightleftharpoons Ag(s) + Br^-$	0.071	
$Ag(S_2O_3)_3^{3-} + e^- \rightleftharpoons Ag(s) + 2S_2O_3^{2-}$	0.017	
$AgI(s) + e^- \rightleftharpoons Ag(s) + I^-$	-0.152	
$Ag_2S(s) + H^+ + 2e^- \rightleftharpoons 2Ag(s) + SH^-$	-0.272	
sodium		
$Na^+ + e^- + Hg \rightleftharpoons Na(in\ Hg)$	-1.959	
$Na^+ + \frac{1}{2}H_2(g) + e^- \rightleftharpoons NaH(s)$	-2.367	-1.550
$Na^+ + e^- \rightleftharpoons Na(s)$	-2.714 3	-0.757

(Continued)

Reaction	E° (volts)	dE°/dT (mV/K)
Strontium		
$\text{Sr}^{2+} + 2e^- \rightleftharpoons \text{Sr}(s)$	-2.889	-0.237
Sulfur		
$\text{S}_2\text{O}_8^{2-} + 2e^- \rightleftharpoons 2\text{SO}_4^{2-}$	2.01	
$\text{S}_2\text{O}_8^{2-} + 4\text{H}^+ + 2e^- \rightleftharpoons 2\text{H}_2\text{SO}_3$	0.57	
$4\text{SO}_2 + 4\text{H}^+ + 6e^- \rightleftharpoons \text{S}_4\text{O}_6^{2-} + 2\text{H}_2\text{O}$	0.539	-1.11
$\text{SO}_2 + 4\text{H}^+ + 4e^- \rightleftharpoons \text{S}(s) + 2\text{H}_2\text{O}$	0.450	-0.652
$2\text{H}_2\text{SO}_3 + 2\text{H}^+ + 4e^- \rightleftharpoons \text{S}_2\text{O}_3^{2-} + 3\text{H}_2\text{O}$	0.40	
$\text{S}(s) + 2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2\text{S}(g)$	0.174	0.224
$\text{S}(s) + 2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2\text{S}(aq)$	0.144	-0.21
$\text{S}_4\text{O}_6^{2-} + 2\text{H}^+ + 2e^- \rightleftharpoons 2\text{HS}_2\text{O}_3^-$	0.10	-0.23
$5\text{S}(s) + 2e^- \rightleftharpoons \text{S}_5^{2-}$	-0.340	
$\text{S}(s) + 2e^- \rightleftharpoons \text{S}^{2-}$	-0.476	-0.925
$2\text{S}(s) + 2e^- \rightleftharpoons \text{S}_2^{2-}$	-0.50	-1.16
$2\text{SO}_3^{2-} + 3\text{H}_2\text{O} + 4e^- \rightleftharpoons \text{S}_2\text{O}_3^{2-} + 6\text{OH}^-$	-0.566	-1.06
$\text{SO}_3^{2-} + 3\text{H}_2\text{O} + 4e^- \rightleftharpoons \text{S}(s) + 6\text{OH}^-$	-0.659	-1.23
$\text{SO}_4^{2-} + 4\text{H}_2\text{O} + 6e^- \rightleftharpoons \text{S}(s) + 8\text{OH}^-$	-0.751	-1.288
$\text{SO}_4^{2-} + \text{H}_2\text{O} + 2e^- \rightleftharpoons \text{SO}_3^{2-} + 2\text{OH}^-$	-0.936	-1.41
$2\text{SO}_3^{2-} + 2\text{H}_2\text{O} + 2e^- \rightleftharpoons \text{S}_2\text{O}_4^{2-} + 4\text{OH}^-$	-1.130	-0.85
$2\text{SO}_4^{2-} + 2\text{H}_2\text{O} + 2e^- \rightleftharpoons \text{S}_2\text{O}_6^{2-} + 4\text{OH}^-$	-1.71	-1.00
Tantalum		
$\text{Ta}_2\text{O}_5(s) + 10\text{H}^+ + 10e^- \rightleftharpoons 2\text{Ta}(s) + 5\text{H}_2\text{O}$	-0.752	-0.377
Technetium		
$\text{TcO}_4^- + 2\text{H}_2\text{O} + 3e^- \rightleftharpoons \text{TcO}_2(s) + 4\text{OH}^-$	-0.366	-1.82
$\text{TcO}_4^- + 4\text{H}_2\text{O} + 7e^- \rightleftharpoons \text{Tc}(s) + 8\text{OH}^-$	-0.474	-1.46
Tellurium		
$\text{TeO}_3^{2-} + 3\text{H}_2\text{O} + 4e^- \rightleftharpoons \text{Te}(s) + 6\text{OH}^-$	-0.47	-1.39
$2\text{Te}(s) + 2e^- \rightleftharpoons \text{Te}_2^{2-}$	-0.84	
$\text{Te}(s) + 2e^- \rightleftharpoons \text{Te}^{2-}$	-0.90	-1.0
Terbium		
$\text{Tb}^{4+} + e^- \rightleftharpoons \text{Tb}^{3+}$	3.1	1.5
$\text{Tb}^{3+} + 3e^- \rightleftharpoons \text{Tb}(s)$	-2.28	0.350
Thallium		
$\text{Tl}^{3+} + 2e^- \rightleftharpoons \text{Tl}^+$	$\left\{ \begin{array}{l} 1.280 \\ 0.77 \text{ 1 F HCl} \\ 1.22 \text{ 1 F H}_2\text{SO}_4 \\ 1.23 \text{ 1 F HNO}_3 \\ 1.26 \text{ 1 F HClO}_4 \end{array} \right.$	0.97
$\text{Tl}^+ + e^- + \text{Hg} \rightleftharpoons \text{Tl}(in \text{ Hg})$	-0.294	
$\text{Tl}^+ + e^- \rightleftharpoons \text{Tl}(s)$	-0.336	-1.312
$\text{TlCl}(s) + e^- \rightleftharpoons \text{Tl}(s) + \text{Cl}^-$	-0.557	
Thorium		
$\text{Th}^{4+} + 4e^- \rightleftharpoons \text{Th}(s)$	-1.826	0.557
Thulium		
$\text{Tm}^{3+} + 3e^- \rightleftharpoons \text{Tm}(s)$	-2.319	0.394
Tin		
$\text{Sn}(\text{OH})_3^+ + 3\text{H}^+ + 2e^- \rightleftharpoons \text{Sn}^{2+} + 3\text{H}_2\text{O}$	0.142	
$\text{Sn}^{4+} + 2e^- \rightleftharpoons \text{Sn}^{2+}$	0.139	1 F HCl
$\text{SnO}_2(s) + 4\text{H}^+ + 2e^- \rightleftharpoons \text{Sn}^{2+} + 2\text{H}_2\text{O}$	-0.094	-0.31
$\text{Sn}^{2+} + 2e^- \rightleftharpoons \text{Sn}(s)$	-0.141	-0.32
$\text{SnF}_6^{2-} + 4e^- \rightleftharpoons \text{Sn}(s) + 6\text{F}^-$	-0.25	
$\text{Sn}(\text{OH})_6^{2-} + 2e^- \rightleftharpoons \text{Sn}(\text{OH})_3^- + 3\text{OH}^-$	-0.93	
$\text{Sn}(s) + 4\text{H}_2\text{O} + 4e^- \rightleftharpoons \text{SnH}_4(g) + 4\text{OH}^-$	-1.316	-1.057
$\text{SnO}_2(s) + \text{H}_2\text{O} + 2e^- \rightleftharpoons \text{SnO}(s) + 2\text{OH}^-$	-0.961	-1.129
Titanium		
$\text{TiO}^{2+} + 2\text{H}^+ + e^- \rightleftharpoons \text{Ti}^{3+} + \text{H}_2\text{O}$	0.1	-0.6
$\text{Ti}^{3+} + e^- \rightleftharpoons \text{Ti}^{2+}$	-0.9	1.5
$\text{TiO}_2(s) + 4\text{H}^+ + 4e^- \rightleftharpoons \text{Ti}(s) + 2\text{H}_2\text{O}$	-1.076	0.365
$\text{TiF}_6^{2-} + 4e^- \rightleftharpoons \text{Ti}(s) + 6\text{F}^-$	-1.191	
$\text{Ti}^{2+} + 2e^- \rightleftharpoons \text{Ti}(s)$	-1.60	-0.16
Tungsten		
$\text{W}(\text{CN})_8^{3-} + e^- \rightleftharpoons \text{W}(\text{CN})_8^{4-}$	0.457	
$\text{W}^{6+} + e^- \rightleftharpoons \text{W}^{5+}$	0.26	12 F HCl
$\text{WO}_3(s) + 6\text{H}^+ + 6e^- \rightleftharpoons \text{W}(s) + 3\text{H}_2\text{O}$	-0.091	-0.389

Reaction	E° (volts)	dE°/dT (mV/K)
$W^{5+} + e^- \rightleftharpoons W^{4+}$	-0.3	12 F HCl
$WO_2(s) + 2H_2O + 4e^- \rightleftharpoons W(s) + 4OH^-$	-0.982	-1.197
$WO_4^{2-} + 4H_2O + 6e^- \rightleftharpoons W(s) + 8OH^-$	-1.060	-1.36
Uranium		
$UO_2^+ + 4H^+ + e^- \rightleftharpoons U^{4+} + 2H_2O$	0.39	-3.4
$UO_2^{2+} + 4H^+ + 2e^- \rightleftharpoons U^{4+} + 2H_2O$	0.273	-1.582
$UO_2^+ + e^- \rightleftharpoons UO_2^+$	0.16	0.2
$U^{4+} + e^- \rightleftharpoons U^{3+}$	-0.577	1.61
$U^{3+} + 3e^- \rightleftharpoons U(s)$	-1.642	0.16
Vanadium		
$VO_2^+ + 2H^+ + e^- \rightleftharpoons VO^{2+} + H_2O$	1.001	-0.901
$VO^{2+} + 2H^+ + e^- \rightleftharpoons V^{3+} + H_2O$	0.337	-1.6
$V^{3+} + e^- \rightleftharpoons V^{2+}$	-0.255	1.5
$V^{2+} + 2e^- \rightleftharpoons V(s)$	-1.125	-0.11
Xenon		
$H_4XeO_6 + 2H^+ + 2e^- \rightleftharpoons XeO_3 + 3H_2O$	2.38	0.0
$XeF_2 + 2H^+ + 2e^- \rightleftharpoons Xe(g) + 2HF$	2.2	
$XeO_3 + 6H^+ + 6e^- \rightleftharpoons Xe(g) + 3H_2O$	2.1	-0.34
Ytterbium		
$Yb^{3+} + 3e^- \rightleftharpoons Yb(s)$	-2.19	0.363
$Yb^{2+} + 2e^- \rightleftharpoons Yb(s)$	-2.76	-0.16
Yttrium		
$Y^{3+} + 3e^- \rightleftharpoons Y(s)$	-2.38	0.034
Zinc		
$ZnOH^+ + H^+ + 2e^- \rightleftharpoons Zn(s) + H_2O$	-0.497	0.03
$Zn^{2+} + 2e^- \rightleftharpoons Zn(s)$	-0.762	0.119
$Zn^{2+} + 2e^- + Hg \rightleftharpoons Zn(in Hg)$	-0.801	
$Zn(NH_3)_4^{2+} + 2e^- \rightleftharpoons Zn(s) + 4NH_3$	-1.04	
$ZnCO_3(s) + 2e^- \rightleftharpoons Zn(s) + CO_3^{2-}$	-1.06	
$Zn(OH)_3^- + 2e^- \rightleftharpoons Zn(s) + 3OH^-$	-1.183	
$Zn(OH)_4^{2-} + 2e^- \rightleftharpoons Zn(s) + 4OH^-$	-1.199	
$Zn(OH)_2(s) + 2e^- \rightleftharpoons Zn(s) + 2OH^-$	-1.249	-0.999
$ZnO(s) + H_2O + 2e^- \rightleftharpoons Zn(s) + 2OH^-$	-1.260	-1.160
$ZnS(s) + 2e^- \rightleftharpoons Zn(s) + S^{2-}$	-1.405	
Zirconium		
$Zr^{4+} + 4e^- \rightleftharpoons Zr(s)$	-1.45	0.67
$ZrO_2(s) + 4H^+ + 4e^- \rightleftharpoons Zr(s) + 2H_2O$	-1.473	-0.344

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*Michelson Laboratory
China Lake, California*



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