Table 18.1 Selected Standard Electrode Potentials at 25 °C

Reduction Half-Reaction	E° Volts
Acidic Solution	
$F_2(g) + 2e^- \longrightarrow 2F^-(aq)$	+2.866
$O_3(g) + 2H^+(aq) + 2e^- \longrightarrow O_2(g) + H_2O(l)$	+2.075
$S_2O_8^{2-}(aq) + 2e^- \longrightarrow 2SO_4^{2-}(aq)$	+2.01
$H_2O_2(aq) + 2H^+(aq) + 2e^- \longrightarrow 2H_2O(l)$	+1.763
$MnO_4^-(aq) + 8H^+(aq) + 5e^- \longrightarrow Mn^{2+}(aq) + 4H_2O(l)$	+1.51
$PbO_2(s) + 4H^+(aq) + 2e^- \longrightarrow Pb^{2+}(aq) + 2H_2O(l)$	+1.455
$Cl_2(g) + 2e^- \longrightarrow 2Cl^-(aq)$	+1.358
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \longrightarrow 2Cr^{3+}(aq) + 7H_2O(l)$	+1.33
$MnO_2(s) + 4H^+(aq) + 2e^- \longrightarrow Mn^{2+}(aq) + 2H_2O(l)$	+1.23
$O_2(g) + 4H^+(aq) + 4e^- \longrightarrow 2H_2O(l)$	+1.229
$2IO_3^-(aq) + 12H^+(aq) + 10e^- \longrightarrow I_2(s) + 6H_2O(l)$	+1.20
$Br_2(l) + 2e^- \longrightarrow 2Br^-(aq)$	+1.065
$NO_3^-(aq) + 4H^+(aq) + 3e^- \longrightarrow NO(g) + 2H_2O(l)$	+0.956
$Ag^+(aq) + e^- \longrightarrow Ag(s)$	+0.800
$Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$	+0.771
$O_2(g) + 2H^+(aq) + 2e^- \longrightarrow H_2O_2(aq)$	+0.695
$I_2(s) + 2e^- \longrightarrow 2I^-(aq)$	+0.535
$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$	+0.340
$SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \longrightarrow 2H_2O(l) + SO_2(g)$	+0.17
$Sn^{4+}(aq) + 2e^- \longrightarrow Sn^{2+}(aq)$	+0.154
$S(s) + 2H^+(aq) + 2e^- \longrightarrow H_2S(g)$	+0.14
$2H^+(aq) + 2e^- \longrightarrow H_2(g)$	0
$Pb^{2+}(aq) + 2e^- \longrightarrow Pb(s)$	−0.125
$Sn^{2+}(aq) + 2e^- \longrightarrow Sn(s)$	−0.137
$Co^{2+}(aq) + 2e^- \longrightarrow Co(s)$	−0.277
$Fe^{2+}(aq) + 2e^- \longrightarrow Fe(s)$	−0.440
$Zn^{2+}(aq) + 2e^- \longrightarrow Zn(s)$	−0.763
$Al^{3+}(aq) + 3e^- \longrightarrow Al(s)$	−1.676
$Mg^{2+}(aq) + 2e^- \longrightarrow Mg(s)$	−2.356
$Na^+(aq) + e^- \longrightarrow Na(s)$	−2.713
$Ca^{2+}(aq) + 2e^- \longrightarrow Ca(s)$	−2.84
$K^+(aq) + e^- \longrightarrow K(s)$	−2.924
$Li^+(aq) + e^- \longrightarrow Li(s)$	−3.040
Basic Solution	
$O_3(g) + H_2O(l) + 2e^- \longrightarrow O_2(g) + 2OH^-(aq)$	+1.246
$OCl^-(aq) + H_2O(l) + 2e^- \longrightarrow Cl^-(aq) + 2OH^-(aq)$	+0.890
$O_2(g) + 2H_2O(l) + 4e^- \longrightarrow 4OH^-(aq)$	+0.401
$2H_2O(l) + 2e^- \longrightarrow H_2(g) + 2OH^-(aq)$	−0.828

IMPORTANT FORMULAS

$\Delta G° = \Sigma n\Delta G°_{prod} - \Sigma m\Delta G°_{react}$ (similar formulas for $\Delta H°$ and $\Delta S°$)

$\Delta G° = -nFE°$

F is the Faraday constant = 96.5 kC (gives an answer in kJ)

$E°_{cell} = \dfrac{0.0592}{n} \log K$

$E_{cell} = E°_{cell} - \dfrac{0.0592}{n} \log Q$

$E°_{cell} = E°_{cathode} - E°_{anode}$

$\Delta G° = \Delta H° - T\Delta S°$

$\Delta G° = -5.71 \log K$ (at 25° C)

$T_{\frac{1}{2}} = \dfrac{0.693}{k}$ first order

$pH = pKa + \log \dfrac{[base]}{[acid]}$

$\log k_2/k_1 = \dfrac{Ea}{19.14} \times \left(\dfrac{1}{T_1} - \dfrac{1}{T_2} \right)$ (gives answer in J)

1 COULOMB = 1 AMP × 1 SEC

$$\text{rate} = k[A]^x[B]^y \qquad (14.1)$$

Rate law expressions. The sum $(x + y)$ gives the overall order of the reaction.

$$\ln \frac{[A]_t}{[A]_0} = -kt \qquad (14.3)$$

Relationship between concentration and time for a first-order reaction.

$$\ln [A]_t = -kt + \ln [A]_0 \qquad (14.4)$$

Equation for the graphical determination of k for a first-order reaction.

$$t_{\frac{1}{2}} = \frac{0.693}{k} \qquad (14.5)$$

Half-life for a first-order reaction.

$$\frac{1}{[A]_t} = kt + \frac{1}{[A]_0} \qquad (14.6)$$

Relationship between concentration and time for a second-order reaction.

$$[A]_t = -kt + [A]_0 \qquad (14.8)$$

Relationship between concentration and time for a zero-order reaction.

$$k = Ae^{-E_a/RT} \qquad (14.10)$$

The Arrhenius equation expressing the dependence of the rate constant on activation energy and temperature.

$$\ln k = \left(-\frac{E_a}{R}\right)\left(\frac{1}{T}\right) + \ln A \qquad (14.12)$$

Equation for the graphical determination of activation energy.

$$\ln \frac{k_1}{k_2} = \frac{E_a}{R}\left(\frac{T_1 - T_2}{T_1 T_2}\right) \qquad (14.13)$$

Relationship of rate constants at two different temperatures.

$R = 8.31 \ J/K$