REDUCTION
(gain of electrons)

decrease in oxidation number

AT CATHODE

⊖ in electrolysis

⊕ in electrochemical cells

STRONGEST OXIDISING AGENTS "oxidants"

WEAKEST REDUCING AGENTS "reductants"

Standard Reduction Potentials at 25°C

Half-reaction			E°(volts)
$F_2(g) + 2\,e^-$	⇌	$2\,F^-(aq)$	+ 2.87
$H_2O_2(aq) + 2\,H^+(aq) + 2\,e^-$	⇌	$2\,H_2O(\ell)$	+ 1.78
$PbO_2(s) + SO_4^{2-}(aq) + 4\,H^+(aq) + 2\,e^-$	⇌	$PbSO_4(s) + 2\,H_2O(\ell)$	+ 1.69
$2\,HClO(aq) + 2\,H^+(aq) + 2\,e^-$	⇌	$Cl_2(g) + 2\,H_2O(\ell)$	+ 1.61
(purple) $MnO_4^-(aq) + 8\,H^+(aq) + 5\,e^-$	⇌	$Mn^{2+}(aq) + 4\,H_2O(\ell)$ (colourless)	+ 1.51
$Au^{3+}(aq) + 3\,e^-$	⇌	$Au(s)$	+ 1.50
$HClO(aq) + H^+(aq) + 2\,e^-$	⇌	$Cl^-(aq) + H_2O(\ell)$	+ 1.48
$PbO_2(s) + 4\,H^+(aq) + 2\,e^-$	⇌	$Pb^{2+}(aq) + 2\,H_2O(\ell)$	+ 1.46
$Cl_2(g) + 2\,e^-$	⇌	$2\,Cl^-(aq)$	+ 1.36
(orange) $Cr_2O_7^{2-}(aq) + 14\,H^+(aq) + 6\,e^-$	⇌	$2\,Cr^{3+}(aq) + 7\,H_2O(\ell)$ (green)	+ 1.23
$O_2(g) + 4\,H^+(aq) + 4\,e^-$	⇌	$2\,H_2O(\ell)$	+ 1.23
$Br_2(\ell) + 2\,e^-$	⇌	$2\,Br^-(aq)$	+ 1.07
$NO_3^-(aq) + 4\,H^+(aq) + 3\,e^-$	⇌	$NO(g) + 2\,H_2O(\ell)$	+ 0.96
$Ag^+(aq) + e^-$	⇌	$Ag(s)$	+ 0.80
$Fe^{3+}(aq) + e^-$	⇌	$Fe^{2+}(aq)$	+ 0.77
$O_2(g) + 2\,H^+(aq) + 2\,e^-$	⇌	$H_2O_2(aq)$	+ 0.68
$I_2(s) + 2\,e^-$	⇌	$2\,I^-(aq)$	+ 0.54
$O_2(g) + 2\,H_2O(\ell) + 4\,e^-$	⇌	$4\,OH^-(aq)$	+ 0.40
$Cu^{2+}(aq) + 2\,e^-$	⇌	$Cu(s)$	+ 0.34
$S(s) + 2\,H^+(aq) + 2\,e^-$	⇌	$H_2S(aq)$	+ 0.14
$2\,H^+(aq) + 2\,e^-$	⇌	$H_2(g)$	0 exactly
$Pb^{2+}(aq) + 2\,e^-$	⇌	$Pb(s)$	− 0.13
$Sn^{2+}(aq) + 2\,e^-$	⇌	$Sn(s)$	− 0.14
$Ni^{2+}(aq) + 2\,e^-$	⇌	$Ni(s)$	− 0.26
$Co^{2+}(aq) + 2\,e^-$	⇌	$Co(s)$	− 0.28
$PbSO_4(s) + 2\,e^-$	⇌	$Pb(s) + SO_4^{2-}(aq)$	− 0.36
$Cd^{2+}(aq) + 2\,e^-$	⇌	$Cd(s)$	− 0.40
$2\,CO_2(g) + 2\,H^+(aq) + 2\,e^-$	⇌	$HOOCCOOH(aq)$	− 0.43
$Fe^{2+}(aq) + 2\,e^-$	⇌	$Fe(s)$	− 0.44
$Cr^{3+}(aq) + 3\,e^-$	⇌	$Cr(s)$	− 0.73
$Zn^{2+}(aq) + 2\,e^-$	⇌	$Zn(s)$	− 0.76
$2\,H_2O(\ell) + 2\,e^-$	⇌	$H_2(g) + 2\,OH^-(aq)$	− 0.83
$Mn^{2+}(aq) + 2\,e^-$	⇌	$Mn(s)$	− 1.18
$Al^{3+}(aq) + 3\,e^-$	⇌	$Al(s)$	− 1.66
$Mg^{2+}(aq) + 2\,e^-$	⇌	$Mg(s)$	− 2.37
$Na^+(aq) + e^-$	⇌	$Na(s)$	− 2.71
$Ca^{2+}(aq) + 2\,e^-$	⇌	$Ca(s)$	− 2.76
$Sr^{2+}(aq) + 2\,e^-$	⇌	$Sr(s)$	− 2.89
$Ba^{2+}(aq) + 2\,e^-$	⇌	$Ba(s)$	− 2.91
$K^+(aq) + e^-$	⇌	$K(s)$	− 2.93

lead acid battery discharge → / ← recharge

very common in redox titrations

cathode reaction in silver plating.

O_2 as oxidant in corrosion

STANDARD HYDROGEN REFERENCE

A REDUCING AGENT IS ABLE TO REDUCE ANY OXIDISING AGENT ABOVE IT ON THE LEFT HAND SIDE

reduced → oxidant

reductant ← oxidised

$Fe^{2+} \rightarrow Fe^{3+}$, a common oxidation in redox titrations.

AN OXIDISING AGENT IS ABLE TO OXIDISE ANY REDUCING AGENT BELOW IT ON THE RIGHT HAND SIDE

reduced → oxidant

reductant ← oxidised

lead acid battery: recharge ⇌ discharge

oxalic acid, a common "standard" in redox titrations

oxidation of Fe in corrosion.

WEAKEST OXIDISING AGENTS "oxidants"

STRONGEST REDUCING AGENTS "reductants"

OXIDATION
(loss of electrons)

increase in oxidation number

AT ANODE

⊕ in electrolysis

⊖ in electrochemical cells