Redox reactions – half equations
Lesson 2

All redox reactions can be divided into two equations called ***half equations*****,** representing the reduction and oxidation processes of the overall redox reaction.

The following rules apply to writing half equations

1) Balance the equation for all elements other than H or O
2) Balance for oxygen by adding water to the side deficient in oxygen.
3) Balance for hydrogen by adding H^+ to the side deficient in H
4) Balance for charge by adding electrons to the most positive side.

Example Write a half equation for the reduction of $Cr_2O_7^{-2}(aq) \rightarrow Cr^{3+}(aq)$ in an acid solution

1) Balance the equation for all elements other than H or O
   $Cr_2O_7^{-2}(aq) \rightarrow 2Cr^{3+}(aq)$
2) Balance for oxygen by adding water to the side deficient in oxygen.
   $Cr_2O_7^{-2}(aq) \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$
3) Balance for hydrogen by adding H^+ to the side deficient in H
   $Cr_2O_7^{-2}(aq) + 14H^+(aq) \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$
4) Balance for charge by adding electrons to the most positive side.
   $Cr_2O_7^{-2}(aq) + 14H^+(aq) + 6e \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$

1) Write the half equations that occur in an acid solution for:

a) $MnO_4^-(aq) / Mn^{2+}(aq)$
b) $CH_3OH(aq) / HCOOH(aq)$
c) $SO_4^{2-}(aq) / SO_2(g)$
d) $NO_3^-(aq) / N_2O_2(g)$

2) Write the half equations that occur in an alkaline solution for the reactions shown below. Click to revise how to change the half equation taking place in an acid solution to one taking place in alkaline solution. The first one is done for you.

$MnO_4^-(aq) / Mn^{2+}(aq)$

Balance the equation as normal for an acid solution.
Balance the equation for all elements other than H or O
$MnO_4^-(aq) \rightarrow Mn^{2+}(aq)$
Balance for oxygen by adding water to the side deficient in oxygen.
$MnO_4^-(aq) \rightarrow Mn^{2+}(aq) + 4H_2O(l)$
Balance for hydrogen by adding H^+ to the side deficient in H
$MnO_4^-(aq) + 8H^+(aq) \rightarrow Mn^{2+}(aq) + 4H_2O(l)$
Balance for charge by adding electrons to the most positive side.
$MnO_4^-(aq) + 8H^+(aq) + 5e \rightarrow Mn^{2+}(aq) + 4H_2O(l)$
Extra steps
Replace H^+ by adding an equivalent number of OH^- ions to both sides and then eliminate water molecules as they appear on both sides.
$MnO_4^-(aq) + 8H^+(aq) + 8OH^-(aq) + 5e \rightarrow Mn^{2+}(aq) + 4H_2O(l) + 8OH^-(aq)$
=> $MnO_4^-(aq) + 8H_2O(l) + 5e \rightarrow Mn^{2+}(aq) + 4H_2O(l) + 8OH^-(aq)$
=> $MnO_4^-(aq) + 4H_2O(l) + 5e \rightarrow Mn^{2+}(aq) + 8OH^-(aq)$

a) $Cr_2O_7^{-2}(aq) / Cr^{3+}(aq)$
b) $SO_4^{2-}(aq) / SO_2(g)$
c) $NO_3^-(aq) / N_2O_2(g)$