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 $Cr_2O_7^{-2}(aq) \rightarrow Cr^{3+}(aq)$

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.
   $Cr_2O_7^{-2}(aq) + 14H^+(aq) + 6e \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$

Write the half equations for:

a) $MnO_4^-(aq) / Mn^{2+}(aq)$
   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.
   $MnO_4^-(aq) + 8H^+(aq) + 5e \rightarrow Mn^{2+}(aq) + 4H_2O(l)$
b) $CH_3OH(aq) / HCOOH(aq)$
   Balance the equation for all elements other than H or O
   $CH_3OH(aq) \rightarrow HCOOH(aq)$
   Balance for oxygen by adding water to the side deficient in oxygen.
   $H_2O(l) + CH_3OH(aq) \rightarrow HCOOH(aq)$
   Balance for hydrogen by adding H^+ to the side deficient in H
   $H_2O(l) + CH_3OH(aq) \rightarrow HCOOH(aq) + 4H^+(aq)$
   Balance for charge by adding electrons to the most positive side.
   $H_2O(l) + CH_3OH(aq) \rightarrow HCOOH(aq) + 4H^+(aq) + 4e$

c) SO_4^{2-} (aq)/ SO_2(g)

Balance the equation for all elements other than H or O

SO_4^{2-} (aq) → SO_2(g)

Balance for oxygen by adding water to the side deficient in oxygen.

SO_4^{2-} (aq) → SO_2(g) + $2H_2O$(l)

Balance for hydrogen by adding H^+ to the side deficient in H

$4H^+$(aq) + SO_4^{2-} (aq) → SO_2(g) + $2H_2O$(l)

Balance for charge by adding electrons to the most positive side.

4e + $4H^+$(aq) + SO_4^{2-} (aq) → SO_2(g) + $2H_2O$(l)

d) NO_3^- (aq) / N_2O_2(g)

Balance the equation for all elements other than H or O

$2NO_3^-$ (aq) → N_2O_2(g)

Balance for oxygen by adding water to the side deficient in oxygen.

$2NO_3^-$ (aq) → N_2O_2(g) + $4H_2O$(l)

Balance for hydrogen by adding H^+ to the side deficient in H

$8H^+$(aq) + $2NO_3^-$ (aq) → N_2O_2(g) + $4H_2O$(l)

Balance for charge by adding electrons to the most positive side.

6e + $8H^+$(aq) + $2NO_3^-$ (aq) → N_2O_2(g) + $4H_2O$(l)

In an alkaline solutions

a) $Cr_2O_7^{-2}$(aq) → $2Cr^{3+}$(aq)

=> write the ewuation as per acidic solutions

$Cr_2O_7^{-2}$(aq) + $14H^+$(aq) + 6e → $2Cr^{3+}$(aq) + $7H_2O$(l)

=> Remove H^+ (aq) by adding OH^-(aq)

$Cr_2O_7^{-2}$(aq) + $14H^+$(aq) $14OH^-$(aq) + 6e → $2Cr^{3+}$(aq) + $7H_2O$(l) + $14OH^-$(aq)

=> $Cr_2O_7^{-2}$(aq) + $14H_2O$(l) + 6e → $2Cr^{3+}$(aq) + $7H_2O$(l) + $14OH^-$(aq)

=> Cancel for water

=> $Cr_2O_7^{-2}$(aq) + $14H_2O$(l) + 6e → $2Cr^{3+}$(aq) + $7H_2O$(l) + $14OH^-$(aq)

=> $Cr_2O_7^{-2}$(aq) + $7H_2O$(l) + 6e → $2Cr^{3+}$(aq) + $14OH^-$(aq)

b) SO_4^{2-} (aq)/ SO_2(g)

2e + $2H_2O$(l) + SO_4^{2-} (aq) → SO_2(g) + $4OH^-$(aq)

c) NO_3^- (aq) / N_2O_2(g)

6e + $4H_2O$(l) + $2NO_3^-$ (aq) → N_2O_2(g) + $8OH^-$(aq)