Balancing Redox Reactions 2 : Notes/W.S. 28

Many redox reactions are difficult to balance by inspection. The best method for balancing these reactions is to break apart the reaction into an oxidation half-reaction and a reduction half-reaction. Then balance each half-reaction and add the two together after multiplying both by a factor to eliminate the electrons on both sides.

Examples:

Balance in an acid solution:

MnO_4^- + H_2S -> Mn^{2+} + S

Sulfur is oxidized:

H_2S + -> S + $2H^+$ + $2e^-$

Mn is reduced:

MnO_4^- + $8H^+$ + $5e^-$ -> Mn^{2+} + $4H_2O$

Adding the two equations after multiplying the first by five and the second by two, we have;

$2MnO_4^-$ + $5H_2S$ + $6H^+$ -> $2Mn^{2+}$ + 5S + $8H_2O$

Balance in a basic solution:

BrO_3^- + F_2 -> BrO_4^- + F^-

Br is oxidized:

BrO_3^- + $2OH^-$ -> BrO_4^- + H_2O + $2e^-$

F is reduced:

F_2 $2e^-$ -> $2F^-$

Adding both equations together we have:

BrO_3^- + F_2 + $2OH^-$ -> BrO_4^- + $2F^-$ + H_2O

1) Balance the following redox reactions in an acid solution.

a) Fe^{2+} + MnO_4^- -> Fe^{3+} + Mn^{2+}

b) Ag + $Cr_2O_7^{2-}$ -> Ag^+ + Cr^{3+}

c) MnO_4^- + Cl^- -> Mn^{2+} + Cl_2

d) FeS + NO_3^- -> Fe^{3+} + NO + SO_4^{2-}

2) Balance the following reactions in a basic solution.

a) CrO_2 + ClO^- -> CrO_4^{2-} + Cl^-

b) MnO_4^- + I^- -> MnO_4^{2-} + IO_4^-

c) $Zn + NO_3^- \rightarrow Zn(OH)_4^{2-} + NH_3$

d) $Cl_2 \rightarrow ClO_4^- + Cl^-$
(Hint: Cl is oxidized and reduced)

Answers: 1)a) $5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$, b) $6Ag + Cr_2O_7^{2-} + 14H^+ \rightarrow 6Ag^+ + 2Cr^{3+} + 7H_2O$, c) $2MnO_4^- + 10Cl^- + 16H^+ \rightarrow 2Mn^{2+} + 5Cl_2 + 8H_2O$, d) $FeS + 3NO_3^- + 4H^+ \rightarrow Fe^{3+} + 3NO + SO_4^{2-} + 2H_2O$, 2)a) $CrO_2 + ClO^- + 2OH^- + \rightarrow CrO_4^{2-} + Cl^- + H_2O$, b) $8MnO_4^- + I^- + 8OH^- \rightarrow 8MnO_4^{2-} + IO_4^- + 4H_2O$, c) $4Zn + NO_3^- + 6H_2O + 7OH^- \rightarrow 4Zn(OH)_4^{2-} + NH_3$, d) $4Cl_2 + 8OH^- \rightarrow ClO_4^- + 7Cl^- + 4H_2O$.