Lecture 20 3 Balancing Redox Reactions

Note Title

Step 1 *Assign oxidation states* to all atoms and identify the substances being oxidized and reduced.

$MnO_4^-(aq) + I^-(aq) \rightarrow MnO_4^{2-}(aq) + IO_3^-(aq)$

+7 −2−2−2−2 = −1 ; −1 ; +6 −2−2−2−2 = −2 ; +5 −2−2−2 = −1

oxidation

reduction

oxidation ½ rxn.

$I^- \rightarrow IO_3^-$

reduction ½ rxn.

$MnO_4^- \rightarrow MnO_4^{-2}$

Step 2 *Separate the overall reaction into two half-reactions:* one for oxidation and one for reduction.

Step 3 *Balance each half-reaction with respect to mass* in the following order:

- Balance all elements other than H and O.
- Balance O by adding H_2O.
- Balance H by adding H^+.

$3H_2O + I^- \rightarrow IO_3^- + 6H^+$

$MnO_4^- \rightarrow MnO_4^{-2}$

oxid: prod

Step 4 *Balance each half-reaction with respect to charge* by adding electrons. (The sum of the charges on both sides of the equation should be made equal by adding as many electrons as necessary.)

$3H_2O + I^- \rightarrow IO_3^- + 6H^+ + 6e^-$

T.C. = −1 ; T.C. = +5 ; T.C. = −1

reactant: reduction

$1e^- + MnO_4^- \rightarrow MnO_4^{-2}$

T.C. = −1 ; T.C. = −2

$1 \cdot (3H_2O + I^- \rightarrow IO_3^- + 6H^+ + 6e^-)$ (6e⁻ lost)

Step 5 *Make the number of electrons in both half-reactions equal* by multiplying one or both half-reactions by a small whole number.

$6 \cdot (1e^- + MnO_4^- \rightarrow MnO_4^{-2})$ (1e⁻ gained)

$3H_2O + I^- \rightarrow IO_3^- + 6H^+ + 6e^-$

$6e^- + 6MnO_4^- \rightarrow 6MnO_4^{-2}$

e⁻ Lost ; # e⁻ gained

Step 6 *Add the two half-reactions together,* canceling electrons and other species as necessary.

$3H_2O + I^- + 6e^- + 6MnO_4^- \rightarrow IO_3^- + 6H^+ + 6e^- + 6MnO_4^{-2}$

Balanced Redox

Acidic Environment

$3H_2O_{(l)} + I^-_{(aq)} + 6MnO_4^-{}_{(aq)} \rightarrow IO_3^-{}_{(aq)} + 6H^+_{(aq)} + 6MnO_4^{2-}{}_{(aq)}$

acidic

Basic Env.

- Neutralize H^+ by adding enough OH^- to neutralize each H^+. Add the same number of OH^- ions to each side of the equation.

Balanced Redox

Basic

$3H_2O_{(l)} + I^-_{(aq)} + 6MnO_4^-{}_{(aq)} \rightarrow IO_3^-{}_{(aq)} + 6H^+_{(aq)} + 6MnO_4^{2-}{}_{(aq)}$

$+6OH^-$; $+6OH^-$; $-6H_2O$; $\div 3$

$I^-_{(aq)} + 6OH^-_{(aq)} + 6MnO_4^-{}_{(aq)} \rightarrow IO_3^-{}_{(aq)} + 3H_2O_{(l)} + 6MnO_4^{2-}{}_{(aq)}$