2. Balancing Redox Reactions – Using Half Reactions

a) Half Reactions

 $Co^{+2} \rightarrow Co$ "unbalanced" Sample 1

Oxidation or reduction?

 $Co^{+2} + 2e \rightarrow Co$ "balanced"

Reduction!!

 $NO \rightarrow N_2O$ "unbalanced" Sample 2

Oxidation or reduction?

 $2NO + 2H^{+} + 2e^{-} \rightarrow N_{2}O + H_{2}O$ "balanced"

Reduction!!

i) Half reactions must be balanced for charge and mass

ii) MAJOR OH

1st balance major atoms,

2nd balance oxygen using water, 3rd balance hydrogen using H⁺

4th balance charge using e-

iii) Acidic vs. Basic solutions

Acidic – proceed as above

Basic – Bonus step: add OH equal to H on both sides; combine H and OH to form H₂O; cancel out water on both sides (between 3rd and 4th steps)

iv) Balance $NO \rightarrow N_2O$ (acidic)

1st Balance for atoms other than O and H

$$2NO \rightarrow N_2O$$

2nd Add water to balance O

$$2\mathrm{NO} \rightarrow \mathrm{N_2O} + \mathrm{H_2O}$$

3rd Add H+ to balance H

$$2NO + 2H^{+} \rightarrow N_{2}O + H_{2}O$$

4th Add e- to balance charge

$$2NO + 2H^{+} + 2e^{-} \rightarrow N_2O + H_2O$$

v) Balance $MnO_4^- \rightarrow Mn^{+2}$ (acidic)

1st Balance for atoms other than O and H

 $MnO_4^- \rightarrow Mn^{+2}$ (Mn already balanced)

2nd Add water to balance O

 $MnO_4^- \rightarrow Mn^{+2} + 4H_2O$

 3^{rd} Add H^+ to balance H

 $MnO_4^- + 8H^+ \rightarrow Mn^{+2} + 4H_2O$

4th Add e- to balance charge

 MnO_4 + $8H^+ + 5e_- \rightarrow Mn^{+2} + 4H_2O$

vi) Balance $Cl_2 \rightarrow ClO_3$ (basic)

 1^{st} Balance for atoms other than O and H

 $Cl_2 \rightarrow 2ClO_3^-$

2nd Add water to balance O

 $Cl_2 + 6H_2O \rightarrow 2ClO_3$

 3^{rd} Add H^+ to balance H

 $Cl_2 + 6H_2O \rightarrow 2ClO_3^- + 12H^+$

Bonus: Add OH-, equal to H+ on both sides

 $Cl_2 + 6H_2O + 12OH^2 \rightarrow 2ClO_3^2 + 12H^4 + 12OH^2$

Combine H^+ and OH^-

 $Cl_2 + 6H_2O + 12OH^2 \rightarrow \ 2ClO_3^2 + 12H_2O$

Cancel out H_2O on both sides

 $\text{Cl}_2 + 12\text{OH}^2 \rightarrow 2\text{ClO}_3^2 + 6\text{H}_2\text{O}$

4th step Add e- to balance charge

 $Cl_2 + 12OH^- \rightarrow 2ClO_3^- + 6H_2O + 10e$

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