Electrochemistry Unit: Assignment 4

Answer Key

Balancing half reactions Practice (practice from lecture in assignment 3)

Directions: for the following reactions:

- Assign oxidation states
- Pull out each half reaction and identify as oxidized or reduced
- Balance mass and charge of each half reaction
- Add together (after the electrons transferred are equal)

$\overset{0}{Ca} + \overset{+2\ -1}{Zn(NO_3)_2} \rightarrow \overset{0}{Zn} + \overset{+2\ -1}{Ca(NO_3)_2}$

$Ca \rightarrow Ca^{2+} + 2e^-$ Ox

$Zn^{2+} + 2e^- \rightarrow Zn$ Red

$Zn^{2+} + Ca \rightarrow Ca^{2+} + Zn$

$\overset{0}{F_2} + \overset{+1\ -1}{NaCl} \rightarrow \overset{0}{Cl_2} + \overset{+1\ -1}{NaF}$

$2e^- + F_2 \rightarrow 2F^-$ Red

$2Cl^- \rightarrow Cl_2 + 2e^-$ Ox

$2Cl^- + F_2 \rightarrow 2F^- + Cl_2$

$F_2 + 2NaCl \rightarrow Cl_2 + 2NaF$

$\overset{0}{Fe} + \overset{+2\ -1}{Sr(NO_3)_2} \rightarrow \overset{0}{Sr} + \overset{+3\ -1}{Fe(NO_3)_3}$

$Fe \rightarrow Fe^{3+} + 3e^-$ Ox

$Sr^{2+} + 2e^- \rightarrow Sr$ Red

$2Fe \rightarrow 2Fe^{3+} + 6e^-$

$3Sr^{2+} + 6e^- \rightarrow 3Sr$

$3Sr^{2+} + 2Fe \rightarrow 3Sr + 2Fe^{3+}$

$2Fe + 3Sr(NO_3)_2 \rightarrow 3Sr + 2Fe(NO_3)_3$

$Cr^{2+} + Mn^{7+} \rightarrow Mn^{5+} + Cr^{3+}$

$Cr^{2+} \rightarrow Cr^{3+} + 1e^-$ Ox

$Mn^{7+} + 2e^- \rightarrow Mn^{5+}$ Red

$2Cr^{2+} \rightarrow 2Cr^{3+} + 2e^-$

$2Cr^{2+} + Mn^{7+} \rightarrow Mn^{5+} + 2Cr^{3+}$

After completing, place in your unit folder

Assignment 6 Answers

Acidic Soln:

1. $MnO_4^- + Cl^- \rightarrow Mn^{2+} + HClO$

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

$H_2O + Cl^- \rightarrow HClO + H^+ + 2e^-$

11 3

$8H^+ + 10e^- + 2MnO_4^- \rightarrow 2Mn^{2+} + 8H_2O$

$5H_2O + 5Cl^- \rightarrow 5HClO + 5H^+ + 10e^-$

+

$11H^+ + 2MnO_4^- + 5Cl^- \rightarrow 2Mn^{2+} + 5HClO + 3H_2O$

2. $NO_3^- + I_2 \rightarrow IO_3^- + NO_2$

$6H_2O + I_2 \rightarrow 2IO_3^- + 12H^+ + 10e^-$

$1e^- + 2H^+ + NO_3^- \rightarrow NO_2 + H_2O$

8 4

$10e^- + 20H^+ + 10NO_3^- \rightarrow 10NO_2 + 10H_2O$

$6H_2O + I_2 \rightarrow 2IO_3^- + 12H^+ + 10e^-$

$8H^+ + 10NO_3^- + I_2 \rightarrow 2IO_3^- + 10NO_2 + 4H_2O$

3. $Cr_2O_7^{2-} + C_2H_5OH \rightarrow Cr^{3+} + CO_2$

$14H^+ + 6e^- + Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O$

$3H_2O + C_2H_5OH \rightarrow 2CO_2 + 12H^+ + 12e^-$

12

$28H^+ + 12e^- + 2Cr_2O_7^{2-} \rightarrow 4Cr^{3+} + 14H_2O$

$16H^+$ 11

$16H^+ + 2Cr_2O_7^{2-} + C_2H_5OH \rightarrow 2CO_2 + 4Cr^{3+} + 11H_2O$

Assignment 6 answers (con't)

Basic Sol'n

4. $PbO_2 + Cl^- \rightarrow ClO^- + Pb(OH)_3^-$

$H_2O + Cl^- \rightarrow ClO^- + 2H^+ + 2e^-$

$2e^- + 2H^+ + H_2O + PbO_2 \rightarrow Pb(OH)_3^-$

$2H_2O + Cl^- + PbO_2 \rightarrow ClO^- + Pb(OH)_3^- + H^+$

Now Basic part

$OH^- + H_2O + Cl^- + PbO_2 \rightarrow ClO^- + Pb(OH)_3^- + H^+ + OH^-$

$H^+ + OH^- \rightarrow H_2O$

Balanced:

$OH^- + H_2O + Cl^- + PbO_2 \rightarrow ClO^- + Pb(OH)_3^-$

5. $MnO_4^- + IO_3^- \rightarrow MnO_2 + IO_4^-$

$3e^- + 4H^+ + MnO_4^- \rightarrow MnO_2 + 2H_2O$

$H_2O + IO_3^- \rightarrow IO_4^- + 2H^+ + 2e^-$

$6e^- + 8H^+ + 2MnO_4^- \rightarrow 2MnO_2 + 4H_2O$

$3H_2O + 3IO_3^- \rightarrow 3IO_4^- + 6H^+ + 6e^-$

$2OH^- + 2H^+ + 2MnO_4^- + 3IO_3^- \rightarrow 3IO_4^- + 2MnO_2 + H_2O + 2OH^-$

$2H_2O$

$H_2O + 2MnO_4^- + 3IO_3^- \rightarrow 3IO_4^- + 2MnO_2 + 2OH^-$

6. $CN^- + MnO_4^- \rightarrow MnO_2 + CNO^-$

$H_2O + CN^- \rightarrow CNO^- + 2H^+ + 2e^-$

$4H^+ + 3e^- + MnO_4^- \rightarrow MnO_2 + 2H_2O$

$3H_2O + 3CN^- \rightarrow 3CNO^- + 6H^+ + 6e^-$

$8H^+ + 6e^- + 2MnO_4^- \rightarrow 2MnO_2 + 4H_2O$

$2H^+ + 2MnO_4^- + 3CN^- \rightarrow 3CNO^- + 2MnO_2 + H_2O$

$2OH^- + 2H^+ + 2MnO_4^- + 3CN^- \rightarrow 3CNO^- + 2MnO_2 + H_2O + 2OH^-$

$2H_2O$

$H_2O + 2MnO_4^- + 3CN^- \rightarrow 3CNO^- + 2MnO_2 + 2OH^-$

Subject

Assignment 9 answers

Date

Acidic

(1) $Pb + H_2SO_4 \rightarrow PbSO_4 + 2H^+ + 2e^-$

$2H^+ + 2e^- + PbO_2 + H_2SO_4 \rightarrow PbSO_4 + 2H_2O$

$Pb + PbO_2 + 2H_2SO_4 \rightarrow 2PbSO_4 + 2H_2O$

(2) $2H^+ + 2e^- + H_2O_2 \longrightarrow H_2O + H_2O$

$2FeSO_4 + H_2SO_4 \Rightarrow Fe_2(SO_4)_3 + 2H^+ + 2e^-$

$2FeSO_4 + H_2SO_4 + H_2O_2 \longrightarrow 2H_2O + Fe_2(SO_4)_3$

[you probably could have balanced straight out!]

(3) $2e^- + Br_2 \rightarrow 2Br^-$

$2H_2O + Br_2^2 \longrightarrow 2OBr^- + 4H^+ + 2e^-$

$2H_2O + 2Br_2 \Rightarrow 2Br^- + 2OBr^- + 4H^+$

Basic

(4) $8H^+ + 6e^- + MnO_4^{2-} \longrightarrow MnO_2 + 2H_2O$

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

$8H^+ + 6e^- + MnO_4^{2-} \longrightarrow MnO_2 + 2H_2O$

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

$8H^+ + 7MnO_4^{2-} \Rightarrow MnO_2 + 6MnO_4^- + 2H_2O$

$8OH^- + 8H^+ + 7MnO_4^{2-} \Rightarrow MnO_2 + 6MnO_4^- + 2\cancel{H_2O} + 8OH^-$

$\cancel{8H_2O}$

$6H_2O + 7MnO_4^{2-} \longrightarrow MnO_2 + 6MnO_4^- + 8OH^-$

Subject | Date

Assignment 9 answers (con't)

Redox Titration Problem

1. $Fe^{2+} \rightarrow Fe^{3+} + 1e^-$

$14H^+ + 6e^- + Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O$

$6Fe^{2+} \rightarrow 6Fe^{3+} + 6e^-$

$14H^+ + 6e^- + Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O$

$14H^+ + 6Fe^{2+} + Cr_2O_7^{2-} \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$

2. Cr is Reduced; Goes from $Cr^{6+} \rightarrow Cr^{3+}$

3. At endpoint we have equivalent moles

$M_{Cr_2O_7^{2-}} V_{Cr_2O_7^{2-}} = \text{moles } Cr_2O_7$

$(.085M)(.046L) = 1.61 \times 10^{-3} \text{ moles } Cr_2O_7^{2-}$

from BCE: 1 mole $Cr_2O_7^{2-}$ reacts with 6 mol Fe^{2+}

$1.61 \times 10^{-3} \text{ moles } Cr_2O_7^{2-} \left| \frac{6 \text{ mol } Fe^{2+}}{1 \text{ mol } Cr_2O_7^{2-}} \right. = 9.66 \times 10^{-3} \text{ mol } Fe^{2+}$

$M = \frac{\text{mol}}{L} = \frac{9.66 \times 10^{-3} \text{ mol}}{.0105 \text{ L}} = .92M \; Fe(NO_3)_2$

4. Using either rxt as a starting point since there is no limiting reactant:

$9.66 \times 10^{-3} \text{ mol } Fe^{2+} \left| \frac{6 \text{ mol } Fe^{3+}}{6 \text{ mol } Fe^{2+}} \right| \frac{55.8 \text{ g } Fe^{3+}}{1 \text{ mol } Fe^{3+}} = .54 \text{ g } Fe^{3+}$

$9.66 \times 10^{-3} \text{ mol } Fe^{2+} \left| \frac{2 \text{ mol } Cr^{3+}}{6 \text{ mol } Fe^{2+}} \right| \frac{52 \text{ g } Cr^{3+}}{1 \text{ mol } Cr^{3+}} = .17 \text{ g } Cr^{3+}$