Chem 10123, Quiz 7 **Answer Key**

April 1, 2020

1. An aqueous solution of $KMnO_4$ is standardized by the following procedure. A 0.9812-g sample of pure $FeSO_4$ (molar mass = 151.92) is dissolved in some dilute acid. This $FeSO_4$ solution is then titrated by careful addition of the $KMnO_4$ solution from a buret. To reach the end point, 35.60 mL of the $KMnO_4$ solution is required.

   (a) (3 points) *Write and* ***balance the net-ionic equation*** for the reaction that occurs during the titration, assuming that the products are Fe^{3+} and Mn^{2+}.

   $$5\ Fe^{2+} + MnO_4^- + 8\ H^+ \longrightarrow 5\ Fe^{3+} + Mn^{3+} + 4\ H_2O$$

   (b) (4 points) **SHOW ALL WORK.** Determine the molarity of the $KMnO_4$ solution.

   $(0.9812\ g\ FeSO_4)\ (1\ mole / 151.92\ g)\ (1\ mole\ Fe^{2+} / 1\ mole\ FeSO_4)$

   $= 0.006459\ mole\ Fe^{2+}$

   $(0.006459\ mole\ Fe^{2+})\ (1\ mole\ MnO_4^- / 5\ mole\ Fe^{2+}) = 0.001292\ mole\ MnO_4^-$

   $(0.001292\ mole\ MnO_4^-) / 03560\ L) = 0.03628\ M\ KMnO_4$

2. (5 points) **SHOW ALL WORK.** A certain metal (M) forms the chloride MCl_3. Electrolysis of molten MCl_3 by a current of 4.00 amp for 15.0 minutes deposits 2.39 g of metal M at the cathode. Perform an appropriate calculation and identify the metal M.

   $$M^{3+} + 3\ e^- \longrightarrow M$$

   $(4.00\ amp)\ (15.0\ min)\ (60\ sec/min) = 3600\ amp{\cdot}sec = 3600\ coul$

   $(3600\ coul)\ (1\ mole\ e^- / 96485\ coul) = 0.03731\ mole\ e^-$

   $(0.03731\ mole\ e^-)\ (1\ mole\ M / 3\ mole\ e^-) = 0.01244\ mole\ M$

   $molar\ mass\ of\ M = 2/39\ g / 0.01244\ mole = 192.9\ g/mole$

   $\therefore\ M = Ir$

3. (8 points) Use the ***ion-electron method*** to balance each of the following redox reactions. For each reaction, write ***complete, balanced equations*** for the individual half-reactions and for the overall net ionic equation.

(a) (acidic solution) $Zn_{(s)} + NO_3^-{}_{(aq)} \longrightarrow N_2O_{(g)} + Zn^{2+}{}_{(aq)}$

Reduction Half Reaction:

$8\ e^- + 10\ H^+ + 2\ NO_3^- \longrightarrow N_2O + 5\ H_2O$

Oxidation Half Reaction:

$Zn \longrightarrow Zn^{2+} + 2\ e^-$ (x 4)

Net Ionic Equation:

$10\ H^+ + 2\ NO_3^- + 4\ Zn \longrightarrow 4\ Zn^{2+} + N_2O + 5\ H_2O$

(b) (basic solution) $BrO_3^-{}_{(aq)} \longrightarrow BrO_4^-{}_{(aq)} + BrO_2^-{}_{(aq)}$

Reduction Half Reaction:

$2\ e^- + H_2O + BrO_3^- \longrightarrow BrO_2^- + 2\ OH^-$

Oxidation Half Reaction:

$2\ OH^- + BrO_3^- \longrightarrow BrO_4^- + H_2O + 2\ e^-$

Net Ionic Equation:

$2\ BrO_3^- \longrightarrow BrO_2^- + BrO_4^-$