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Post Lab 0 Questions

(Q1)

(a) $PbO_2 + I^- \rightarrow Pb^{2+} + I_2$

Reduction:
$PbO_2 \rightarrow Pb^{2+}$
+4 -2 +2
$PbO_2 + 2e^- + 4H^+ \rightarrow Pb^{2+} + 2H_2O$

Oxidation:
$I^- \rightarrow I_2$
$2I^- \rightarrow I_2$
-1 +0
$2I^- \rightarrow I_2 + 2e^-$

Combined: $PbO_2 + 4H^+ + 2I^- \rightarrow Pb^{2+} + 2H_2O + I_2$

(b) $SO_3^{2-} + MnO_4^- \rightarrow SO_4^{2-} + Mn^{2+}$

Reduction:
$MnO_4^- \rightarrow Mn^{2+}$
+7 -2 +2
$MnO_4^- + 5e^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O$

Oxidation:
$SO_3^{2-} \rightarrow SO_4^{2-}$
+4 -2 +6 -2
$SO_3^{2-} + H_2O \rightarrow SO_4^{2-} + 2H^+ + 2e$

Combined: $2MnO_4^- + 16H^+ + 5SO_3^- + 5H_2O \rightarrow 2Mn^{2+} + 8H_2O + 5SO_4^{2-} + 10H^+$
$2MnO_4^- + 6H^+ + 5SO_3^- \rightarrow 2Mn^{2+} + 3H_2O + 5SO_4^{2-}$

(c) $S_2O_3^{2-} + Cl_2 \rightarrow SO_4^{2-} + Cl^-$

Reduction:
$Cl_2 \rightarrow Cl^-$
$Cl_2 \rightarrow 2Cl^-$
+0 -1
$Cl_2 + 2e^- \rightarrow 2Cl^-$

Oxidation:
$S_2O_3^{2-} \rightarrow SO_4^{2-}$
$S_2O_3^{2-} \rightarrow 2SO_4^{2-}$
+2 -2 +6 -2
$S_2O_3^{2-} + H_2O \rightarrow 2SO_4^{2-} + 8e^- + 2H^+$

Combined: $4Cl_2 + S_2O_3^{2-} + H_2O \rightarrow 8Cl^- + 2SO_4^{2-} + 2H^+$

Q2 (a) $H_2O_2 + ClO_2 \rightarrow ClO_2^- + O_2$

Reduction:
$ClO_2 \rightarrow ClO_2^-$
+4 -2 +3 -2
$ClO_2 + e^- \rightarrow ClO_2^-$

Oxidation:
$H_2O_2 \rightarrow O_2$
+1 -1 +0
$H_2O_2 \rightarrow O_2 + 2e^- + 2H^+$

Combined: $2ClO_2 + H_2O_2 \rightarrow 2ClO_2^- + O_2 + 2H^+$

In basic solution: $2ClO_2 + H_2O_2 + 2OH^- \rightarrow 2ClO_2^- + O_2 + 2H_2O$

(b) $Al + MnO_4^- \rightarrow MnO_2 + Al(OH)_4^-$

Reduction
$MnO_4^- \rightarrow MnO_2$
+7 -2 +4 -2
$4H^+ + MnO_4^- + 3e^- \rightarrow MnO_2 + 2H_2O$
$2H_2O + MnO_4^- + 3e^- \rightarrow MnO_2 + 4OH^-$

Oxidation:
$Al \rightarrow Al(OH)_4^-$
+0 +3 -1
$4OH^- + Al \rightarrow Al(OH)_4^- + 3e^-$

Combined: $2H_2O + MnO_4^- + Al \rightarrow MnO_2 + Al(OH)_4$

(c) $Cl_2 \rightarrow Cl^- + ClO^-$

Reduction:
$Cl_2 \rightarrow Cl^-$
$Cl_2 \rightarrow 2Cl^-$
$+0 \quad -1$
$Cl_2 + 2e^- \rightarrow 2Cl^-$

Oxidation:
$Cl_2 \rightarrow ClO^-$
$Cl_2 \rightarrow 2ClO^-$
$+0 \quad +1 \quad -2$
$Cl_2 + 2H_2O \rightarrow 2ClO^- + 2e^- + 4H^+$
$Cl_2 + 4OH^- \rightarrow 2ClO^- + 2e^- + 2H_2O$

Combined: $2Cl_2 + 4OH^- \rightarrow 2ClO^- + 2Cl^- + 2H_2O$
$Cl_2 + 2OH^- \rightarrow ClO^- + Cl^- + H_2O$

Q3) (a) $MnO_4^- + Zn \rightarrow Mn^{2+} + Zn^{2+}$

Reduction
$MnO_4^- \rightarrow Mn^{2+}$
$+7 \quad -2 \qquad +2$
$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

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

Combined: $2MnO_4^- + 16H^+ + 5Zn \rightarrow 2Mn^{2+} + 8H_2O + 5Zn^{2+}$

(b) $2.85\,g\ Zn \times \frac{1\,mol\ Zn}{65.38} \times \frac{2\,mol\ MnO_4^-}{5\,mol\ Zn} \times \frac{1\,mol\ KMnO_4^-}{1\,mol\ MnO_4^-} = 0.0174\ mol\ KMnO_4$

$Volume = \frac{mol}{M} = \frac{0.0174}{0.500} = 0.0349\,L = 34.9\,mL$ 0.500M $KMnO_4$ Solution.

(Q4) Potassium Iodate Molar mass = 213.999 g/mol., IO_3^- = 174.901 g/mol, KI = 166.002 g/mol

$mol = M \cdot volume = 0.02 \times 0.25000 = 0.005\,mol\ KIO_3 \times \frac{213.999\,g}{1\,mol\ KIO_3} = 1.07\,g\ KIO_3$

(b) $mol = 0.02 \times 0.02500 = 0.0005\,mol\ KIO_3 = 0.0005\,mol\ IO_3^- * \frac{174.901\,g}{1\,mol\ IO_3^-} = 0.087\,g\ IO_3^-$

(c) (i) 0.02M IO_3^-. (ii) 0.0005 mol IO_3^-

(iii) $IO_3^- + 6H^+ + 8I^- \rightleftharpoons 3I_3^- + 3H_2O$

(iv) $0.005\,mol\ IO_3^- \times \frac{8\,mol\ I^-}{1\,mol\ IO_3^-} \times \frac{1\,mol\ KI}{1\,mol\ I^-} \times \frac{166.002\,g\ KI}{1\,mol\ KI} = 6.64\,g\ KI$

Q5. (a) Because Iodine, in the presence of excess iodide, forms the triiodide ion, which forms a redox equilibrium reaction for the basis of Iodometric titration.

(b) $1.022\,g\ KIO_3 \times \frac{1\,mol\ KIO_3}{213.999\,g\ KIO_3} = 0.00477\,g\ KIO_3 / 0.500L = 0.0010\,M\ KIO_3$.

$IO_3^- + 6H^+ + 8I^- \rightleftharpoons 3I_3^- + 3H_2O$

$0.0010M\ KIO_3 \times 0.0500L = 0.00005\,mol\ IO_3^- \times \frac{3\,mol\ I_3^-}{1\,mol\ IO_3^-} = 0.00015\,mol\ I_3^-$

(c) $2S_2O_3^{2-} \rightarrow S_4O_6^{2-}$
$+2 \quad -2 \qquad +2.5 \quad -2$

$2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2e^-$
oxidation

$I_3^- \rightarrow 3I^-$
$-1/3 \qquad -1$
$I_3^- + 2e^- \rightarrow 3I^-$
reduction

Combined: $2S_2O_3^{2-} + I_3^- \rightarrow S_4O_6^{2-} + 3I^-$

(d) $0.00015\ \text{mol } I_3^- \times \frac{2\ \text{mol } S_2O_3^{2-}}{1\ \text{mol } I_3^-} = \frac{0.00030\ \text{mol } S_2O_3}{0.03766} = 0.00797\ M$

$Na_2S_2O_3$

(e) $0.00787\ M \times 0.01422 = 0.000113\ \text{mol } S_2O_3^{2-} \times \frac{1\ \text{mol } I_3^-}{2\ \text{mol } S_2O_3^{2-}} = 5.66\times10^{-5}\ \text{mol } I_3^-$

$0.00015 - 5.66\times10^{-5} = 0.0000934\ \text{mol } I_3^-$ consumed by ascorbic acid

$9.34\times10^{-5}\ \text{mol } I_3^- \times \frac{1\ \text{mol } IO_3^-}{3\ \text{mol } I_3^-} \times \frac{3\ \text{mol } HIO}{1\ \text{mol } IO_3^-} \times \frac{176.13\ g}{1\ \text{mol } HIO} = \frac{0.0164\ g\ HIO}{1.2235} =$

1.34% ascorbic acid.

Q6. $0.05000\ L \times 0.1186\ M\ Ce^{4+} = 0.00593\ \text{mol } Ce^{4+}$

$0.03113\ L \times 0.04289\ M\ Fe^{2+} \times \frac{1\ \text{mol } Ce^{4+}}{1\ \text{mol } Fe^{2+}} = 0.001335\ \text{mol } Ce^{4+}$ unused.

$0.00593 - 0.001335 = 0.00459\ \text{mol } Ce^{4+}$ used $\times \frac{1\ \text{mol } NO_2^-}{2\ \text{mol } Ce^{4+}} = 0.002230\ \text{mol } NO_2^-$

$\frac{0.00230\ \text{mol } NO_2^-}{0.02500} = 0.0919\ M\ NO_2^- \times 0.500\ L = 0.459\ \text{mol } NO_2^- \times \frac{68.995\ g\ NaNO_2}{1\ \text{mol } NO_2^-}$

$= \frac{3.17\ g\ NaNO_2}{4.030\ g\ \text{sample}}$

78.6% $NaNO_2$.