Key.

Chemistry 12 Electrochemistry Worksheet No. 1

1. Balance the following half reactions and state whether oxidation or reduction is taking place.

a. BrO_3^- ----> Br^- (basic) $BrO_3^- + 3H_2O + 6e^- \rightarrow Br^- + 6OH^-$ reduction
b. $HClO_2$ ----> ClO_3^- (acidic) $HClO_2 + H_2O \rightarrow ClO_3^- + 3H^+ + 2e^-$ oxidation
c. Ga -------> $H_2GaO_3^-$ (basic) $Ga + 4OH^- \rightarrow H_2GaO_3^- + H_2O + 3e^-$ oxidation
d. ReO_4^- ----> ReO_2 (acidic) $ReO_4^- + 4H^+ + 3e^- \rightarrow ReO_2 + 2H_2O$ reduction
e. MnO_2 -----> MnO_4^- (acidic) $MnO_2 + 2H_2O \rightarrow MnO_4^- + 4H^+ + 3e^-$ oxidation
f. N_2O_4 -----> NO (acidic) $N_2O_4 + 4H^+ + 4e^- \rightarrow 2NO + 2H_2O$ reduction
g. CrO_4^{2-} ---> $Cr(OH)_3$ (basic) $CrO_4^{2-} + 4H_2O + 3e^- \rightarrow Cr(OH)_3 + 5OH^-$ reduction
h. $Sn(OH)_6^{2-}$ -> $HSnO_2^-$ (basic) $Sn(OH)_6^{2-} + 2e^- \rightarrow HSnO_2^- + H_2O + 3OH^-$ reduction

2. Use half reactions to balance the following redox reactions and underline the oxidizing agent.

a. $Cl_2 + ClO_3^-$ -----> ClO^- (acidic) $2Cl_2 + ClO_3^- + 2H_2O \rightarrow 5ClO^- + 4H^+$
b. $MnO_4^- + C_2O_4^{2-}$ -----> $Mn(OH)_3 + CO_3^{2-}$ (basic) $MnO_4^- + 2C_2O_4^{2-} + 5OH^- \rightarrow Mn(OH)_3 + 4CO_3^{2-}$
c. $IO_3^- + I^-$ -----> I_3^- (acidic) $IO_3^- + 8I^- + 6H^+ \rightarrow 3I_3^- + 3H_2O$
d. $ClO_4^- + Mn^{2+}$ ------> $Cl^- + MnO_2$ $ClO_4^- + 4Mn^{2+} + 4H_2O \rightarrow Cl^- + 4MnO_2 + 8H^+$
e. $IO_3^- + H_2O_2$ -------> $I_2 + O_2$ $2IO_3^- + 5H_2O_2 + 2H^+ \rightarrow I_2 + 5O_2 + 6H_2O$
f. $MnO_2 + Sn^{4+}$ -------> $MnO_4^- + Sn^{2+}$ $2MnO_2 + 3Sn^{4+} + 4H_2O \rightarrow 2MnO_4^- + 3Sn^{2+} + 8H^+$
g. $NO_3^- + Br_2$ -------> NO + BrO_3^- $10NO_3^- + 3Br_2 + 4H_2O \rightarrow 10NO + 6BrO_3^- + 2H_2O$
h. $H_2O_2 + I^-$ -------> $H_2O + I_2$ (acidic) $H_2O_2 + 2I^- + 2H^+ \rightarrow 2H_2O + I_2$
i. $Cr_2O_7^{2-} + Fe^{2+}$ ---> $Cr^{3+} + Fe^{3+}$ (acidic) $Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$
j. $Cu + NO_3^-$ -------> Cu^{2+} + NO (acidic) $3Cu + 2NO_3^- + 8H^+ \rightarrow 3Cu^{2+} + 2NO + 4H_2O$
k. HBr + H_2SO_4 -----> $SO_2 + Br_2 + H_2O$ $2HBr + H_2SO_4 \rightarrow Br_2 + SO_2 + 2H_2O$
l. HNO_3 + HCl ------> NO + Cl_2 + H_2O $2HNO_3 + 6HCl \rightarrow 2NO + 3Cl_2 + 4H_2O$
m. Zn + HNO_3 -------> $Zn(NO_3)_2$ + NH_4NO_3 + H_2O $4Zn + 10HNO_3 \rightarrow 4Zn(NO_3)_2 + NH_4NO_3 + 3H_2O$
n. HBrO -----> HBr + $HBrO_3$ $3HBrO \rightarrow 2HBr + HBrO_3$
o. ClO_2^- + MnO_2 -----> ClO^- + MnO_4^- (basic) $3ClO_2^- + 2MnO_2 + 2OH^- \rightarrow 3ClO^- + 2MnO_4^- + H_2O$
p. $V^{2+} + H_2SO_3$ ------> $V^{3+} + S_2O_3^{2-}$ $4V^{2+} + 2H_2SO_3 + 2H^+ \rightarrow 4V^{3+} + S_2O_3^{2-} + 3H_2O$
q. Mn + $IrCl_6^{3-}$ -----> Mn^{2+} + Ir + Cl^- $3Mn + 2IrCl_6^{3-} \rightarrow 3Mn^{2+} + 2Ir + 12Cl^-$

3. Iodine is recovered from iodates in Chilean saltpeter ($NaIO_3$) by the reaction described in this unbalanced equation:

$$HSO_3^- + IO_3^- \text{ -----> } I_2 + SO_4^{2-} \quad \text{(acidic solution)}$$

What mass of iodine is produced when a 20 kg sample of $NaIO_3$ reacts with excess HSO_3^- ?

$5HSO_3^- + 2IO_3^- \rightarrow I_2 + 5SO_4^{2-} + H_2O + 3H^+$

$20\,000\,g \left(\frac{1\,mole}{198\,g}\right) = 101\ moles$

$101\ moles\ IO_3^- \left(\frac{1\,mole\ I_2}{2\,mole\ IO_3^-}\right) = 50.5\ moles\ I_2 \left(\frac{254\,g}{1\,mole}\right)$

$= 13.0\ kg.$