

Key.

### Chemistry 12 Electrochemistry Worksheet No. 1

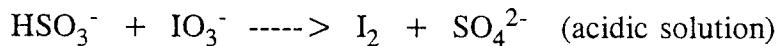
1. Balance the following half reactions and state whether oxidation or reduction is taking place.

a. $\text{BrO}_3^- \rightarrow \text{Br}^-$	(basic)	$\text{BrO}_3^- + 3\text{H}_2\text{O} + 6e^- \rightarrow \text{Br}^- + 6\text{OH}^-$	reduction
b. $\text{HClO}_2 \rightarrow \text{ClO}_3^-$	(acidic)	$\text{HClO}_2 + \text{H}_2\text{O} \rightarrow \text{ClO}_3^- + 3\text{H}^+ + 2e^-$	oxidation
c. $\text{Ga} \rightarrow \text{H}_2\text{GaO}_3^-$	(basic)	$\text{Ga} + 4\text{OH}^- \rightarrow \text{H}_2\text{GaO}_3^- + \text{H}_2\text{O} + 3e^-$	oxidation
d. $\text{ReO}_4^- \rightarrow \text{ReO}_2$	(acidic)	$\text{ReO}_4^- + 4\text{H}^+ + 3e^- \rightarrow \text{ReO}_2 + 2\text{H}_2\text{O}$	reduction
e. $\text{MnO}_2 \rightarrow \text{MnO}_4^-$	(acidic)	$\text{MnO}_2 + 2\text{H}_2\text{O} \rightarrow \text{MnO}_4^- + 4\text{H}^+ + 3e^-$	oxidation
f. $\text{N}_2\text{O}_4 \rightarrow \text{NO}$	(acidic)	$\text{N}_2\text{O}_4 + 4\text{H}^+ + 4e^- \rightarrow 2\text{NO} + 2\text{H}_2\text{O}$	reduction
g. $\text{CrO}_4^{2-} \rightarrow \text{Cr(OH)}_3$	(basic)	$\text{CrO}_4^{2-} + 4\text{H}_2\text{O} + 3e^- \rightarrow \text{Cr(OH)}_3 + 5\text{OH}^-$	reduction
h. $\text{Sn(OH)}_6^{2-} \rightarrow \text{HSnO}_2^-$	(basic)	$\text{Sn(OH)}_6^{2-} + 2e^- \rightarrow \text{HSnO}_2^- + \text{H}_2\text{O} + 3\text{OH}^-$	reduction

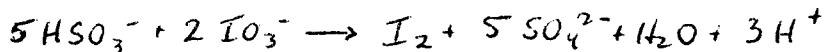
2. Use half reactions to balance the following redox reactions and underline the oxidizing agent.

a. $\text{Cl}_2 + \text{ClO}_3^- \rightarrow \text{ClO}^-$ (acidic)	$2\text{Cl}_2 + \text{ClO}_3^- + 2\text{H}_2\text{O} \rightarrow 5\text{ClO}^- + 4\text{H}^+$
b. $\text{MnO}_4^- + \text{C}_2\text{O}_4^{2-} \rightarrow \text{Mn(OH)}_3 + \text{CO}_3^{2-}$ (basic)	$\text{MnO}_4^- + 2\text{C}_2\text{O}_4^{2-} + 3\text{OH}^- \rightarrow \text{Mn(OH)}_3 + 4\text{CO}_3^{2-}$
c. $\text{IO}_3^- + \text{I}^- \rightarrow \text{I}_3^-$ (acidic)	$\text{IO}_3^- + 8\text{I}^- + 6\text{H}^+ \rightarrow 3\text{I}_3^- + 3\text{H}_2\text{O}$
d. $\text{ClO}_4^- + \text{Mn}^{2+} \rightarrow \text{Cl}^- + \text{MnO}_2$	$\text{ClO}_4^- + 4\text{Mn}^{2+} + 4\text{H}_2\text{O} \rightarrow \text{Cl}^- + 4\text{MnO}_2 + 8\text{H}^+$
e. $\text{IO}_3^- + \text{H}_2\text{O}_2 \rightarrow \text{I}_2 + \text{O}_2$	$2\text{IO}_3^- + 5\text{H}_2\text{O}_2 + 2\text{H}^+ \rightarrow \text{I}_2 + 5\text{O}_2 + 6\text{H}_2\text{O}$
f. $\text{MnO}_2 + \text{Sn}^{4+} \rightarrow \text{MnO}_4^- + \text{Sn}^{2+}$	$2\text{MnO}_2 + 3\text{Sn}^{4+} + 4\text{H}_2\text{O} \rightarrow 2\text{MnO}_4^- + 3\text{Sn}^{2+} + 8\text{H}^+$
g. $\text{NO}_3^- + \text{Br}_2 \rightarrow \text{NO} + \text{BrO}_3^-$	$10\text{NO}_3^- + 3\text{Br}_2 + 4\text{H}_2\text{O} \rightarrow 10\text{NO} + 6\text{BrO}_3^- + 2\text{H}_2\text{O}$
h. $\text{H}_2\text{O}_2 + \text{I}^- \rightarrow \text{H}_2\text{O} + \text{I}_2$ (acidic)	$\text{H}_2\text{O}_2 + 2\text{I}^- + 2\text{H}^+ \rightarrow 2\text{H}_2\text{O} + \text{I}_2$
i. $\text{Cr}_2\text{O}_7^{2-} + \text{Fe}^{2+} \rightarrow \text{Cr}^{3+} + \text{Fe}^{3+}$ (acidic)	$\text{Cr}_2\text{O}_7^{2-} + 6\text{Fe}^{2+} + 14\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 6\text{Fe}^{3+} + 7\text{H}_2\text{O}$
j. $\text{Cu} + \text{NO}_3^- \rightarrow \text{Cu}^{2+} + \text{NO}$ (acidic)	$3\text{Cu} + 2\text{NO}_3^- + 8\text{H}^+ \rightarrow 3\text{Cu}^{2+} + 2\text{NO} + 4\text{H}_2\text{O}$
k. $\text{HBr} + \text{H}_2\text{SO}_4 \rightarrow \text{SO}_2 + \text{Br}_2 + \text{H}_2\text{O}$	$2\text{HBr} + \text{H}_2\text{SO}_4 \rightarrow \text{Br}_2 + \text{SO}_2 + 2\text{H}_2\text{O}$
l. $\text{HNO}_3 + \text{HCl} \rightarrow \text{NO} + \text{Cl}_2 + \text{H}_2\text{O}$	$2\text{HNO}_3 + 6\text{HCl} \rightarrow 2\text{NO} + 3\text{Cl}_2 + 4\text{H}_2\text{O}$
m. $\text{Zn} + \text{HNO}_3 \rightarrow \text{Zn(NO}_3)_2 + \text{NH}_4\text{NO}_3 + \text{H}_2\text{O}$	$4\text{Zn} + 10\text{HNO}_3 \rightarrow 4\text{Zn(NO}_3)_2 + \text{NH}_4\text{NO}_3 + 3\text{H}_2\text{O}$
n. $\text{HBrO} \rightarrow \text{HBr} + \text{HBrO}_3$	$3\text{HBrO} \rightarrow 2\text{HBr} + \text{HBrO}_3$
o. $\text{ClO}_2 + \text{MnO}_2 \rightarrow \text{ClO}^- + \text{MnO}_4^-$ (basic)	$3\text{ClO}_2 + 2\text{MnO}_2 + 2\text{OH}^- \rightarrow 3\text{ClO}^- + 2\text{MnO}_4^- + \text{H}_2\text{O}$
p. $\text{V}^{2+} + \text{H}_2\text{SO}_3 \rightarrow \text{V}^{3+} + \text{S}_2\text{O}_3^{2-}$	$4\text{V}^{2+} + 2\text{H}_2\text{SO}_3 + 2\text{H}^+ \rightarrow 4\text{V}^{3+} + \text{S}_2\text{O}_3^{2-} + 3\text{H}_2\text{O}$
q. $\text{Mn} + \text{IrCl}_6^{3-} \rightarrow \text{Mn}^{2+} + \text{Ir} + \text{Cl}^-$	$3\text{Mn} + 2\text{IrCl}_6^{3-} \rightarrow 3\text{Mn}^{2+} + 2\text{Ir} + 12\text{Cl}^-$

3. Iodine is recovered from iodates in Chilean saltpeter ( $\text{NaIO}_3$ ) by the reaction described in this unbalanced equation:



What mass of iodine is produced when a 20 kg sample of  $\text{NaIO}_3$  reacts with excess  $\text{HSO}_3^-$ ?



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

$$101\text{ moles } \text{IO}_3^- \left( \frac{1\text{ mole I}_2}{2\text{ mole IO}_3^-} \right) = 50.5\text{ moles I}_2 \left( \frac{254\text{ g}}{1\text{ mole}} \right)$$

$$= 13.0\text{ kg.}$$