

## CH 302 Worksheet 11 Balancing Redox Reactions

Half-reaction	$\Delta E_r^0$ (V)
$\text{Li}^+(\text{aq}) + \text{e}^- \rightarrow \text{Li}(\text{s})$	-3.05
$\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Al}(\text{s})$	-1.68
$\text{TiO}(\text{s}) + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{Ti}(\text{s}) + \text{H}_2\text{O}$	-1.31
$\text{Ti}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Ti}(\text{s})$	-1.21
$\text{Ni}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Ni}(\text{s})$	-0.25
$\text{CO}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{HCOOH}(\text{aq})$	-0.11
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$	0
$\text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+ + 2\text{e}^- \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{SO}_2(\text{aq})$	+0.17
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$	+0.34
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{NO}_3^-(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{NO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$	+0.80
$\text{Au}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Au}(\text{s})$	+1.52
$\text{Ag}_2\text{O}_3(\text{s}) + 6\text{H}^+ + 4\text{e}^- \rightarrow 2\text{Ag}^+(\text{aq}) + 3\text{H}_2\text{O}$	+1.67
$\text{F}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{F}^-(\text{aq})$	+2.87

**For questions 1-5, determine whether, as written, the reaction is a battery (“galvanic”) or electrolytic. Balance the reaction and then indicate which species is receiving the electrons and the sign of the cell for that electrode.**

*Note: These problems are harder than the problems on the next page. It was just convenient to put them here.*

1.  $\text{TiO}(\text{s}) + \text{Au}(\text{s}) \rightarrow \text{Au}^{3+}(\text{aq}) + \text{Ti}(\text{s})$  *in acid*
  
2.  $\text{TiO}(\text{s}) + \text{Au}(\text{s}) \rightarrow \text{Au}^{3+}(\text{aq}) + \text{Ti}(\text{s})$  *in base*
  
3.  $\text{Ag}^+(\text{aq}) + \text{F}_2(\text{g}) \rightarrow \text{F}^-(\text{aq}) + \text{Ag}_2\text{O}_3(\text{s})$  *in base*
  
4.  $\text{SO}_4^{2-}(\text{aq}) + \text{Al}(\text{s}) \rightarrow \text{Al}^{3+}(\text{aq}) + \text{SO}_2(\text{aq})$  *in acid*
  
5.  $\text{NO}_3^- + \text{Ag}^+(\text{aq}) \rightarrow \text{Ag}_2\text{O}_3(\text{s}) + \text{NO}_2(\text{g})$  *in acid*

**For the table on the following page, fill in the requested information for a battery made from the two indicated half-reactions**

Half-reaction 1	Half-reaction 2	Cath.	An.	Balanced Reaction	$\Delta E$	Strongest ox. agent	Strongest red. agent
$\text{Ni}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Ni}(\text{s})$	$2\text{H}^{+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{H}_2(\text{g})$	2	1	$2\text{H}^{+}(\text{aq}) + \text{Ni}(\text{s}) \rightarrow \text{Ni}^{2+}(\text{aq}) + \text{H}_2(\text{g})$	+0.25	$\text{H}^{+}$	Ni
$\text{F}_2(\text{g}) + 2\text{e}^{-} \rightarrow 2\text{F}^{-}(\text{aq})$	$\text{Li}^{+}(\text{aq}) + \text{e}^{-} \rightarrow \text{Li}(\text{s})$						
$\text{Al}^{3+}(\text{aq}) + 3\text{e}^{-} \rightarrow \text{Al}(\text{s})$	$\text{Ti}^{3+}(\text{aq}) + 3\text{e}^{-} \rightarrow \text{Ti}(\text{s})$						
$\text{F}_2(\text{g}) + 2\text{e}^{-} \rightarrow 2\text{F}^{-}(\text{aq})$	$2\text{H}^{+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{H}_2(\text{g})$						
$2\text{H}^{+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{H}_2(\text{g})$	$\text{Fe}^{3+}(\text{aq}) + \text{e}^{-} \rightarrow \text{Fe}^{2+}(\text{aq})$						
$\text{Fe}^{3+}(\text{aq}) + \text{e}^{-} \rightarrow \text{Fe}^{2+}(\text{aq})$	$\text{Ni}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Ni}(\text{s})$						
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$	$\text{Au}^{3+}(\text{aq}) + 3\text{e}^{-} \rightarrow \text{Au}(\text{s})$						
$\text{Fe}^{3+}(\text{aq}) + \text{e}^{-} \rightarrow \text{Fe}^{2+}(\text{aq})$	$\text{Li}^{+}(\text{aq}) + \text{e}^{-} \rightarrow \text{Li}(\text{s})$						
$\text{Ti}^{3+}(\text{aq}) + 3\text{e}^{-} \rightarrow \text{Ti}(\text{s})$	$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$						
$\text{Fe}^{3+}(\text{aq}) + \text{e}^{-} \rightarrow \text{Fe}^{2+}(\text{aq})$	$\text{F}_2(\text{g}) + 2\text{e}^{-} \rightarrow 2\text{F}^{-}(\text{aq})$						