

Electrochemistry: Problem Set 10

Alphabetical Reduction Potential Table	
Half-reaction	E°
$\text{Ag}^+ + 1 \text{e}^- \rightarrow \text{Ag (s)}$	$E^{\circ} = +0.80 \text{ V}$
$\text{Al}^{3+} + 3 \text{e}^- \rightarrow \text{Al (s)}$	$E^{\circ} = -1.66 \text{ V}$
$\text{Au}^{3+} + 3 \text{e}^- \rightarrow \text{Au (s)}$	$E^{\circ} = +1.40 \text{ V}$
$\text{Cd}^{2+} + 2 \text{e}^- \rightarrow \text{Cd (s)}$	$E^{\circ} = -0.40 \text{ V}$
$\text{Cr}^{3+} + 3\text{e}^- \rightarrow \text{Cr(s)}$	$E^{\circ} = -0.74 \text{ V}$
$\text{Cu}^{2+} + 2 \text{e}^- \rightarrow \text{Cu (s)}$	$E^{\circ} = +0.34 \text{ V}$
$\text{Cu}^+ + 1 \text{e}^- \rightarrow \text{Cu (s)}$	$E^{\circ} = +0.52 \text{ V}$
$\text{Fe}^{3+} + 1\text{e}^- \rightarrow \text{Fe}^{2+}$	$E^{\circ} = +0.77 \text{ V}$
$\text{Hg}^{2+} + 2 \text{e}^- \rightarrow \text{Hg(l)}$	$E^{\circ} = +1.62 \text{ V}$
$\text{Li}^+ + 1 \text{e}^- \rightarrow \text{Li (s)}$	$E^{\circ} = -3.05 \text{ V}$
$\text{Ni}^{2+} + 2 \text{e}^- \rightarrow \text{Ni (s)}$	$E^{\circ} = -0.23 \text{ V}$
$\text{Pb}^{4+} + 2 \text{e}^- \rightarrow \text{Pb}^{2+}$	$E^{\circ} = +1.67 \text{ V}$
$\text{Pb}^{2+} + 2 \text{e}^- \rightarrow \text{Pb}$	$E^{\circ} = -0.13 \text{ V}$
$\text{Sn}^{4+} + 4 \text{e}^- \rightarrow \text{Sn (s)}$	$E^{\circ} = +0.0136 \text{ V}$
$\text{Sn}^{4+} + 2 \text{e}^- \rightarrow \text{Sn}^{2+}$	$E^{\circ} = +0.15 \text{ V}$
$\text{Sn}^{2+} + 2 \text{e}^- \rightarrow \text{Sn (s)}$	$E^{\circ} = -0.14 \text{ V}$
$\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn (s)}$	$E^{\circ} = -0.76 \text{ V}$

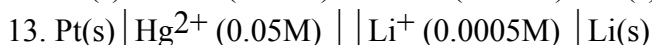
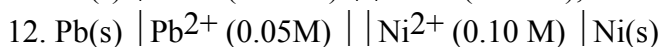
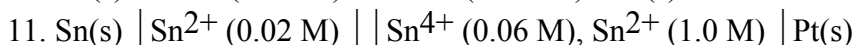
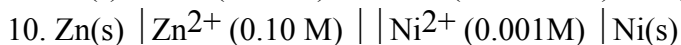
A. For the following batteries (using the above table), determine the following:

- the half reactions for the anode and cathode
- the balanced reaction for the battery
- the standard potential for the cell
- the free energy change for the cell
- the K_{eq} for the cell
- if the battery works as set up

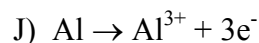
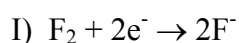
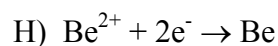
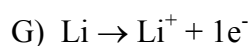
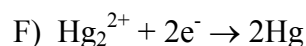
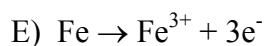
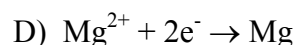
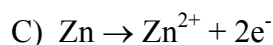
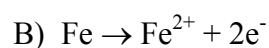
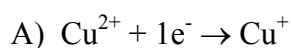
- $\text{Pt(s)} \mid \text{Fe}^{2+}(\text{aq}), \text{Fe}^{3+}(\text{aq}) \parallel \text{Ag}^+(\text{aq}) \mid \text{Ag(s)}$
- $\text{Pt(s)} \mid \text{Pb}^{2+}(\text{aq}), \text{Pb}^{4+}(\text{aq}) \parallel \text{Al}^{3+}(\text{aq}) \mid \text{Al(s)}$
- $\text{Cu(s)} \mid \text{Cu}^{2+}(\text{aq}) \parallel \text{Cu}^+(\text{aq}) \mid \text{Cu(s)}$
- $\text{Au(s)} \mid \text{Au}^{3+}(\text{aq}) \parallel \text{Ag}^+(\text{aq}) \mid \text{Ag(s)}$
- $\text{Li(s)} \mid \text{Li}^+(\text{aq}) \parallel \text{Hg}^{2+}(\text{aq}) \mid \text{Hg(l)}$
- $\text{Cd} \mid \text{Cd}^{2+} \parallel \text{Hg}^{2+} \mid \text{Hg(l)}$
- $\text{Ni} \mid \text{Ni}^{2+} \parallel \text{Cd}^{2+} \mid \text{Cd}$
- $\text{Sn} \mid \text{Sn}^{4+}(\text{aq}) \parallel \text{Sn}^{2+}(\text{aq}) \mid \text{Sn}$

B. For the above batteries, write the nomenclature that would make those batteries that do not work, work.

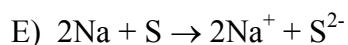
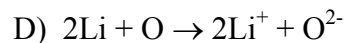
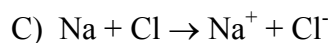
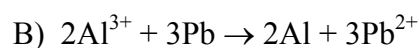
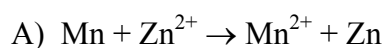
C. For the following batteries, determine the E_{cell} (using the above table):



14. Identify which of the following reactions are reduction or oxidation reactions:



15. Given the following reactions, determine which reactant is oxidized and which reactant is reduced:



16. Based on your responses to #15, above, which reactant is the oxidizing agent and which reactant is the reducing agent?

17. Based upon your new understanding of “simple” redox reactions, balance the following reactions:

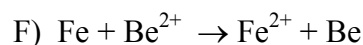
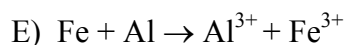
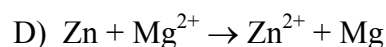
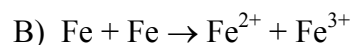
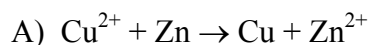
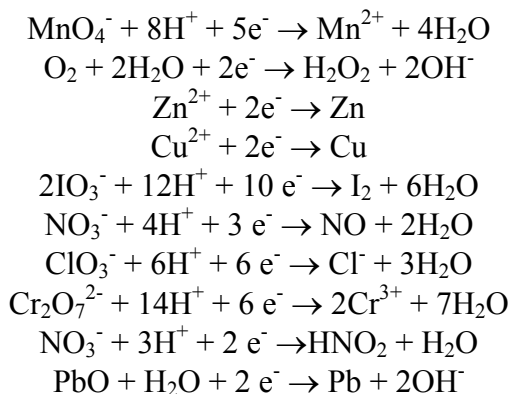


Table of Half Reactions

IMPORTANT: When necessary, turn the reactions around to fit your needs – do NOT, however, change the contents of the half-reactions



18. Balance the following reactions by each of the first two methods of balancing redox reactions:

- | | |
|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| A) $\text{Zn} + \text{NO}_3^- \rightarrow \text{Zn}^{2+} + \text{N}_2\uparrow$ | B) $\text{NO}_3^- + \text{I}_2 \rightarrow \text{IO}_3^- + \text{NO}_2\uparrow$ |
| C) $\text{Cu} + \text{NO}_3^- \rightarrow \text{Cu}^{2+} + \text{NO}_2\uparrow$ | D) $\text{H}_2\text{O}_2 + \text{MnO}_4^- \rightarrow \text{Mn}^{2+} + \text{O}_2\uparrow$ |
| E) $\text{CuS} + \text{NO}_3^- \rightarrow \text{Cu}^{2+} + \text{S} + \text{NO}\uparrow$ | F) $\text{NO}_3^- + \text{Zn} \rightarrow \text{NH}_3\uparrow + \text{Zn}(\text{OH})_4^{2-}$ |
| G) $\text{ClO}_3^- + \text{I}_2 \rightarrow \text{IO}_3^- + \text{Cl}^-$ | H) $\text{Cr}_2\text{O}_7^{2-} + \text{HNO}_2 \rightarrow \text{Cr}^{3+} + \text{NO}_3^-$ |
| I) $\text{H}_2\text{SO}_4 + \text{HBr} \rightarrow \text{SO}_2\uparrow + \text{Br}_2\uparrow$ | J) $\text{C} + \text{HNO}_3 \rightarrow \text{NO}_2\uparrow + \text{CO}_2\uparrow$ |

19. Balance the following reactions from #1, above, by the third method: D, G and H.

20. Balance the following reactions by whichever methods you so desire:

- | | |
|-------------------------------------------------------------------|--------------------------------------------------------------------------|
| A) $\text{NO}_3^- + \text{Pb} \rightarrow \text{NO} + \text{PbO}$ | B) $\text{Cl}^- + \text{Zn}^{2+} \rightarrow \text{ClO}_3^- + \text{Zn}$ |
|-------------------------------------------------------------------|--------------------------------------------------------------------------|

21. Draw a simple battery and label its parts.

22. Oxidation in a battery occurs at which electrode?

23. Reduction in a battery occurs at which electrode?

24. Draw and label an electrolytic cell.

25. Explain how corrosion on a piece of metal works as a battery.