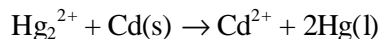


# 21 • Electron Transfer Reactions

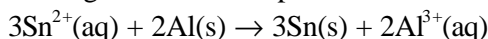
## PRACTICE TEST

1. Which of the following is the correct cell notation for the reaction



- $\text{Cd}^{2+} | \text{Cd} || \text{Hg}_2^{2+} | \text{Hg}$
- $\text{Cd}^{2+} | \text{Hg}_2^{2+} || \text{Cd} | \text{Hg}$
- $\text{Cd} | \text{Cd}^{2+} || \text{Hg}_2^{2+} | \text{Hg}$
- $\text{Cd}^{2+} | \text{Hg} | \text{Hg}_2^{2+} | \text{Cd}$
- $\text{Hg} | \text{Cd} || \text{Hg}_2^{2+} | \text{Cd}^{2+}$

2. Consider an electrochemical cell where the following reaction takes place:



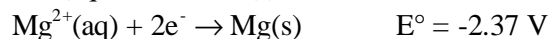
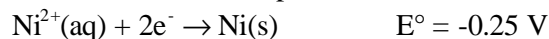
Which of the following is the correct cell notation for this cell?

- $\text{Al} | \text{Al}^{3+} || \text{Sn}^{2+} | \text{Sn}$
- $\text{Al}^{3+} | \text{Al} || \text{Sn} | \text{Sn}^{2+}$
- $\text{Sn} | \text{Sn}^{2+} || \text{Al}^{3+} | \text{Al}$
- $\text{Sn} | \text{Al}^{3+} || \text{Al} | \text{Sn}^{2+}$
- $\text{Al} | \text{Sn}^{2+} || \text{Sn} | \text{Al}^{3+}$

### Standard Reduction Potentials at 25°C E° (volts)

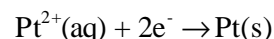
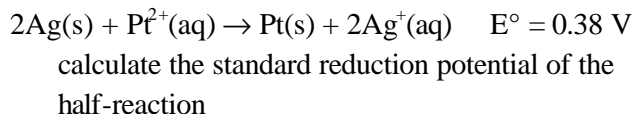
$\text{F}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{F}^-(\text{aq})$	+2.87
$\text{Au}^{3+} + 3\text{e}^- \rightarrow \text{Au(s)}$	+1.50
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{Cl}^-(\text{aq})$	+1.36
$\text{O}_2(\text{g}) + 4\text{H}_3\text{O}^+(\text{aq}) + 4\text{e}^- \rightarrow 6\text{H}_2\text{O(l)}$	+1.23
$\text{Br}_2(\text{l}) + 2\text{e}^- \rightarrow 2\text{Br}^-(\text{aq})$	+1.08
$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag(s)}$	+0.80
$\text{Hg}_2^{2+}(\text{aq}) + 2\text{e}^- \rightarrow 2\text{Hg(l)}$	+0.79
$\text{I}_2(\text{s}) + 2\text{e}^- \rightarrow 2\text{I}^-(\text{aq})$	+0.535
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu(s)}$	+0.337
$\text{Sn}^{4+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Sn}^{2+}(\text{aq})$	+0.15
$\text{Sn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Sn(s)}$	-0.14
$\text{Cd}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cd(s)}$	-0.40
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn(s)}$	-0.763
$2\text{H}_2\text{O(l)} + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$	-0.828
$\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Al(s)}$	-1.66
$\text{K}^+(\text{aq}) + \text{e}^- \rightarrow \text{K(s)}$	-2.93
$\text{Li}^+(\text{aq}) + \text{e}^- \rightarrow \text{Li(s)}$	-3.045

3. Given the two half reactions and their potentials, which net reaction is spontaneous?



- $\text{Ni(s)} + \text{Mg}^{2+}(\text{aq}) \rightarrow \text{Mg(s)} + \text{Ni}^{2+}(\text{aq})$
  - $\text{Ni}^{2+}(\text{aq}) + \text{Mg(s)} \rightarrow \text{Mg}^{2+}(\text{aq}) + \text{Ni(s)}$
  - $\text{Ni(s)} + \text{Mg(s)} \rightarrow \text{Mg}^{2+}(\text{aq}) + \text{Ni}^{2+}(\text{aq})$
  - $\text{Mg}^{2+}(\text{aq}) + \text{Ni}^{2+}(\text{aq}) \rightarrow \text{Mg(s)} + \text{Ni(s)}$
  - $\text{Mg}^{2+}(\text{aq}) + \text{Mg(s)} \rightarrow \text{Ni(s)} + \text{Ni}^{2+}(\text{aq})$
4. Calculate E° for the following reaction:
- $$\text{Sn}^{4+}(\text{aq}) + 2\text{K(s)} \rightarrow \text{Sn}^{2+}(\text{aq}) + 2\text{K}^+(\text{aq})$$
- +6.00 V
  - 3.08 V
  - +3.08 V
  - +2.78 V
  - 2.78 V
5. Calculate E° for the following reaction:
- $$2\text{Al}^{3+}(\text{aq}) + 3\text{Cd(s)} \rightarrow 2\text{Al(s)} + 3\text{Cd}^{2+}(\text{aq})$$
- 2.06 V
  - +4.52 V
  - +2.06 V
  - 4.52 V
  - 1.26 V

6. Using data from the reduction potential table and the reaction



- 1.18 V
  - 0.40 V
  - 0.40 V
  - 1.18 V
  - 2.00 V
7. Using data from the reduction potential table, predict which of the following is the best oxidizing agent.
- $\text{F}_2$
  - $\text{Ag}$
  - $\text{Sn}^{4+}$
  - $\text{Ag}^+$
  - $\text{Al}^{3+}$

8. An electrochemical cell of notation  $\text{Pd} | \text{Pd}^{2+} || \text{Cu}^{2+} | \text{Cu}$  has an  $E^\circ = -0.65 \text{ V}$ . If we know that the standard reduction potential of  $\text{Cu}^{2+}/\text{Cu}$  is  $E^\circ = 0.34 \text{ V}$ , what is the standard reduction potential for  $\text{Pd}^{2+}/\text{Pd}$ ?
- 0.99 V
  - 0.31 V
  - +0.31 V
  - 0.62 V
  - +0.99 V
9. The standard cell potential for  $3\text{Sn}^{4+}(\text{aq}) + 2\text{Al}(\text{s}) \rightarrow 3\text{Sn}^{2+}(\text{aq}) + 2\text{Al}^{3+}(\text{aq})$  is  $E^\circ = 1.81 \text{ V}$ . What is  $E_{\text{cell}}$  when  $[\text{Sn}^{4+}] = 1.0$ ,  $[\text{Sn}^{2+}] = 1.0 \times 10^{-2}$ , and  $[\text{Al}^{3+}] = 1.5 \times 10^{-3}$  at 298 K.
- 1.70 V
  - 1.76 V
  - 1.81 V
  - 1.86 V
  - 1.93 V
10. Predict the product at the anode when electric current is passed through a solution of KI.
- $\text{I}_2(\text{l})$
  - $\text{K}^+(\text{aq})$
  - $\text{H}_2(\text{g})$
  - $\text{K}(\text{s})$
  - $\text{O}_2(\text{g})$
11. If electric current is passed through aqueous LiBr, the product at the cathode would be \_\_\_\_\_ and the product at the anode would be \_\_\_\_\_.
- $\text{H}_2\text{O}(\text{l}), \text{Li}^+(\text{aq})$
  - $\text{Br}_2(\text{l}), \text{Li}(\text{s})$
  - $\text{Li}(\text{s}), \text{Br}_2(\text{l})$
  - $\text{Br}_2(\text{l}), \text{H}_2(\text{g})$
  - $\text{H}_2(\text{g}), \text{Br}_2(\text{l})$
12. How long would it take to deposit 1.36 g of copper from an aqueous solution of copper(II) sulfate by passing a current of two amperes through the solution?
- 2070 sec
  - $1.11 \times 10^{-5}$  sec
  - 2570 sec
  - 736 sec
  - 1030 sec
13. If a current of 6.0 amps is passed through a solution of  $\text{Ag}^+$  for 1.5 hours, how many grams of silver are produced?
- 0.60 g
  - 36 g
  - 0.34 g
  - 3.0 g
  - 1.0 g
14. How is aluminum currently produced in industry?
- by reduction of  $\text{Al}^{3+}$  in  $\text{Al}_2\text{O}_3$  with  $\text{Na}(\text{s})$
  - electrochemical reduction of pure  $\text{Al}_2\text{O}_3$  to give Al and  $\text{O}_2$
  - electrolysis of  $\text{AlF}_3$  to give Al and  $\text{F}_2$
  - electrolysis of a mixture of  $\text{Al}_2\text{O}_3$  and  $\text{Na}_3\text{AlF}_6$  to give Al and  $\text{O}_2$
  - by reduction of  $\text{Al}^{3+}$  in  $\text{Al}_2\text{O}_3$  with  $\text{CO}(\text{g})$
15. How was aluminum originally made?
- the Hall-Heroult process
  - $\text{Al}_2\text{O}_3$  mixed with cryolite is electrolyzed
  - electrolysis of molten  $\text{Al}_2\text{O}_3$
  - mining and purifying directly
  - reducing  $\text{AlCl}_3$  with sodium
16. Under acidic conditions the bromate ion is reduced to the bromide ion. Write the balanced half-reaction for this process.
- $\text{BrO}_3^- + 6\text{H}^+ + 6\text{e}^- \rightarrow \text{Br}^- + 3\text{H}_2\text{O}$
  - $2\text{BrO}_3^- + 6\text{H}^+ \rightarrow \text{Br}_2 + 6\text{H}_2\text{O} + 3\text{e}^-$
  - $\text{BrO}_3^- + 6\text{H}_2\text{O} + 10\text{e}^- \rightarrow \text{Br}_2 + 12\text{H}^+ + 3\text{O}_2$
  - $2\text{BrO}_3^- + 6\text{H}_2\text{O} \rightarrow 2\text{Br}^- + 12\text{H}^+ + 6\text{O}_2 + 8\text{e}^-$
  - $2\text{BrO}_3^- + 6\text{H}^+ \rightarrow \text{Br}_2 + 3\text{H}_2\text{O} + 3\text{e}^-$
17. Balance the following redox equation which occurs in acidic solution.
- $$\text{N}_2\text{H}_4(\text{g}) + \text{BrO}_3^-(\text{aq}) \rightarrow \text{Br}^-(\text{aq}) + \text{N}_2(\text{g})$$
- $3\text{N}_2\text{H}_4 + \text{BrO}_3^- \rightarrow 3\text{N}_2 + \text{Br}^- + 3\text{H}_2\text{O} + 6\text{H}^+$
  - $\text{N}_2\text{H}_4 + \text{BrO}_3^- + 2\text{H}^+ \rightarrow 2\text{Br}^- + \text{N}_2 + 3\text{H}_2\text{O}$
  - $3\text{N}_2\text{H}_4 + 2\text{BrO}_3^- + 12\text{H}^+ \rightarrow 3\text{N}_2 + 2\text{Br}^- + 6\text{H}_2\text{O} + 12\text{H}^+$
  - $\text{N}_2\text{H}_4 + 2\text{BrO}_3^- + 8\text{H}^+ \rightarrow 2\text{Br}^- + \text{N}_2 + 6\text{H}_2\text{O}$
  - $3\text{N}_2\text{H}_4 + 2\text{BrO}_3^- \rightarrow 3\text{N}_2 + 2\text{Br}^- + 6\text{H}_2\text{O}$
18. Which of the following reactions is NOT a redox reaction?
- $2\text{HgO}(\text{s}) \rightarrow 2\text{Hg}(\text{l}) + \text{O}_2(\text{g})$
  - $\text{H}_2(\text{g}) + \text{Br}_2(\text{g}) \rightarrow 2\text{HBr}(\text{g})$
  - $2\text{HCl}(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{H}_2(\text{g}) + \text{ZnCl}_2(\text{aq})$
  - $\text{H}_2\text{CO}_3(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
  - $2\text{KClO}_3 \rightarrow 2\text{KCl}(\text{s}) + 3\text{O}_2(\text{g})$
- 1.C 2.A 3.B 4.C 5.E 6.D 7.A 8.E 9.E 10.A  
11.E 12.A 13.B 14.D 15.E 16.A 17.E 18.D