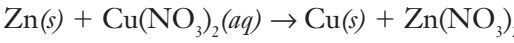
# EMF FOR GALVANIC CELLS

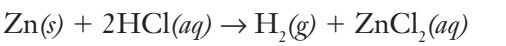
NAME _____ SECTION _____

1. a. What was the cell potential (in units of volts) for the reaction between zinc metal and copper (II) nitrate? (The cell potential was measured in the previous DCI on Galvanic Cells.)[†]



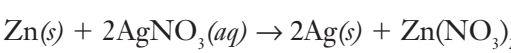
$$Zn(s) + Cu(NO_3)_2(aq) \rightarrow Cu(s) + Zn(NO_3)_2(aq)$$

b. What was the cell potential (in units of volts) for the reaction between zinc metal and hydrochloric acid?



$$Zn(s) + 2HCl(aq) \rightarrow H_2(g) + ZnCl_2(aq)$$

c. What was the cell potential (in units of volts) for the reaction between zinc metal and silver (I) nitrate?



$$Zn(s) + 2AgNO_3(aq) \rightarrow 2Ag(s) + Zn(NO_3)_2(aq)$$

2. a. Explain the term *electromotive force* and the unit *volt*.

b. How is the emf in an electrochemical cell measured?

[†] If you do not have access to this DCI Web site, your instructor will provide you with the data you will need.

c. Explain the term standard emf and explain the importance of a reference half-reaction. Write the equation for the reference half-reaction and its emf.

d. Based on the reference hydrogen electrode, determine the standard reduction potential for $Zn^{2+}(aq)$.

e. Based on the reference hydrogen electrode, determine the standard reduction potential for $Ag^{+}(aq)$.

f. Write the reaction between silver (I) nitrate and hydrochloric acid and calculate the emf for the reaction. Check the reaction using the simulation.

3. Using the table of Standard Reduction Potentials which follows, identify:

   a. the substance most likely to be oxidized

   b. the substance most likely to be reduced

   c. the strongest oxidizing agent

   d. the strongest reducing agent

4. Using the table of Standard Reduction Potentials on the next page, complete the following problems:

   a. Which of the following species is the strongest oxidizing agent, $MnO_4^-$ (in acidic solution), $Br_2(l)$, or $Ca^{2+}(aq)$?

   b. Will aluminum displace $Cu^{2+}$ ion from an aqueous solution of $Cu(NO_3)_2$?

   c. Will Mg displace $Sn^{2+}$ from an aqueous solution of tin (II) nitrate?

   d. Will lead metal dissolve in 1 M HCl?

   e. From the following information estimate the E° for

   $$M^{2+}(aq) + 2e^- \rightarrow M(s)$$

   The metal, M, dissolves in 1 M $HNO_3$ but not in 1 M HCl. It will displace $Ag^+(aq)$, but not $Cu^{2+}(aq)$.

| Standard Reduction Potentials at 25°C | | | |
|---|---|---|---|
| Half–Reaction | | | E° |
| $F_2(g) + 2e^-$ | → | $2F^-(aq)$ | +2.87 v |
| $H_2O_2(aq) + 2H^+(aq) + 2e^-$ | → | $2H_2O(l)$ | +1.77 v |
| $MnO_4^-(aq) + 8H^+(aq) + 5e^-$ | → | $Mn^{2+}(aq) + 4H_2O(l)$ | +1.52 v |
| $Au^{3+}(aq) + 3e^-$ | → | $Au(s)$ | +1.50 v |
| $Cl_2(g) + 2e^-$ | → | $2Cl^-(aq)$ | +1.36 v |
| $Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^-$ | → | $2Cr^{3+}(aq) + 7H_2O(l)$ | +1.33 v |
| $O_2(g) + 4H^+(aq) + 4e^-$ | → | $2H_2O(l)$ | +1.23 v |
| $Br_2(l) + 2e^-$ | → | $2Br^-(aq)$ | +1.07 v |
| $NO_3^-(aq) + 4H^+(aq) + 3e^-$ | → | $NO(g) + 2H_2O(l)$ | +0.96 v |
| $Ag^+(aq) + 1e^-$ | → | $Ag(s)$ | +0.80 v |
| $I_2(s) + 2e^-$ | → | $2I^-(aq)$ | +0.53 v |
| $O_2(g) + 2H_2O(l) + 4e^-$ | → | $4OH^-(aq)$ | +0.40 v |
| $Cu^{2+}(aq) + 2e^-$ | → | $Cu(s)$ | +0.34 v |
| $AgCl(s) + 1e^-$ | → | $Ag(s) + Cl^-(aq)$ | +0.22 v |
| $2H^+(aq) + 2e^-$ | → | $H_2(s)$ | 0.00 v |
| $Pb^{2+}(aq) + 2e^-$ | → | $Pb(s)$ | −0.13 v |
| $Sn^{2+}(aq) + 2e^-$ | → | $Sn(s)$ | −0.136 v |
| $Ni^{2+}(aq) + 2e^-$ | → | $Ni(s)$ | −0.25 v |
| $Co^{2+}(aq) + 2e^-$ | → | $Co(s)$ | −0.28 v |
| $Fe^{2+}(aq) + 2e^-$ | → | $Fe(s)$ | −0.44 v |
| $Zn^{2+}(aq) + 2e^-$ | → | $Zn(s)$ | −0.76 v |
| $2H_2O(l) + 2e^-$ | → | $H_2(g) + 2OH^-(aq)$ | −0.83 v |
| $Cr^{2+}(aq) + 2e^-$ | → | $Cr(s)$ | −0.91 v |
| $Mn^{2+}(aq) + 2e^-$ | → | $Mn(s)$ | −1.18 v |
| $Al^{3+}(aq) + 3e^-$ | → | $Al(s)$ | −1.66 v |
| $Mg^{2+}(aq) + 2e^-$ | → | $Mg(s)$ | −2.37 v |
| $Na^+(aq) + 1e^-$ | → | $Na(s)$ | −2.71 v |
| $Ca^{2+}(aq) + 2e^-$ | → | $Ca(s)$ | −2.87 v |
| $Ba^{2+}(aq) + 2e^-$ | → | $Ba(s)$ | −2.90 v |
| $K^+(aq) + 1e^-$ | → | $K(s)$ | −2.93 v |
| $Li^+(aq) + 1e^-$ | → | $Li(s)$ | −3.05 v |