20.41 From each of the following pairs of substances, use data in Appendix E to choose the one that is the stronger reducing agent:

(a) $Fe(s)$ or $Mg(s)$

(b) $Ca(s)$ or $Al(s)$

(c) $H_2(g$, acidic solution) or $H_2S(g)$

(d) $H_2SO_3(aq)$ or $H_2C_2O_4(aq)$

20.50 For each of the following reactions, write a balanced equation, calculate the standard emf, calculate ΔG° at 298 K, and calculate the equilibrium constant K at 298 K.

(a) Aqueous iodide ion is oxidized to $I_2(s)$ by $Hg_2^{2+}(aq)$.

(b) In acidic solution, copper(I) ion is oxidized to copper(II) ion by nitrate ion. **(c)** In basic solution, $Cr(OH)_3(s)$ is oxidized to $CrO_4^{2-}(aq)$ by $ClO^-(aq)$.

20.55 A cell has a standard emf of +0.177 V at 298 K. What is the value of the equilibrium constant for the cell reaction **(a)** if $n = 1$? **(b)** if $n = 2$? **(c)** if $n = 3$?

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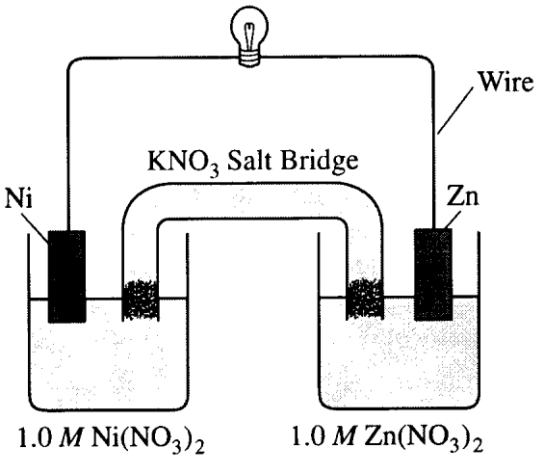

Answer the following questions that refer to the galvanic cell shown in the diagram above. (A table of standard reduction potentials is printed on the green insert and on page 4 of the booklet with the pink cover.)

(a) Identify the anode of the cell and write the half reaction that occurs there.
(b) Write the net ionic equation for the overall reaction that occurs as the cell operates and calculate the value of the standard cell potential, E°_{cell}.
(c) Indicate how the value of E_{cell} would be affected if the concentration of $Ni(NO_3)_{2(aq)}$ was changed from 1.0 *M* to 0.10 *M* and the concentration of $Zn(NO_3)_{2(aq)}$ remained at 1.0 *M*. Justify your answer.
(d) Specify whether the value of K_{eq} for the cell reaction is less than 1, greater than 1, or equal to 1. Justify your answer.

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Answer parts (a) through (e) below, which relate to reactions involving silver ion, Ag^+.
The reaction between silver ion and solid zinc is represented by the following equation.

$$2\ Ag^{+}_{(aq)} + Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2\ Ag_{(s)}$$

(a) A 1.50 g sample of Zn is combined with 250. mL of 0.110 *M* $AgNO_3$ at 25˚C.
  (i) Identify the limiting reactant. Show calculations to support your answer.
  (ii) On the basis of the limiting reactant that you identified in part (i), determine the value of $[Zn^{2+}]$ after the reaction is complete. Assume that volume change is negligible.
(b) Determine the value of the standard potential, E°, for a galvanic cell based on the reaction between $AgNO_{3(aq)}$ and solid Zn at 25˚C.

Another galvanic cell is based on the reaction between $Ag^{+}_{(aq)}$ and $Cu_{(s)}$, represented by the equation below. At 25˚C, the standard potential, E°, for the cell is 0.46 V.

$$2\ Ag^{+}_{(aq)} + Cu_{(s)} \rightarrow Cu^{2+}_{(aq)} + 2\ Ag_{(s)}$$

(c) Determine the value of the standard free-energy change, ΔG°, for the reaction between $Ag^{+}_{(aq)}$ and $Cu_{(s)}$ at 25˚C.
(d) The cell is constructed so that $[Cu^{2+}]$ is 0.045 *M* and $[Ag^+]$ is 0.010 *M*. Calculate the value of the potential, *E*, for the cell.
(e) Under the conditions specified in part (d), is the reaction in the cell spontaneous? Justify your answer.

For the following use dimensional analysis to try and answer the questions. It may be helpful to use the following relationships: 1 amp = 1 coulomb/sec, and 96500c/mol e^-

Example: Calculate the number of grams of Al produced in 1 hr by the electrolysis of molten $AlCl_3$ if the electrical current is 10.0 A
$Al^{3+} + 3e^- \rightarrow Al$

$$1\text{ hr} \times \frac{3600\text{ s}}{1\text{ hr}} \times \frac{10\text{ coulombs}}{1\text{ sec}} \times \frac{1\text{ mol } e^-}{96500\text{ coulombs}} \times \frac{1\text{ mol Al}}{3\text{ mol } e^-} \times \frac{27\text{ g Al}}{1\text{mol}} = 3.36\text{ g Al}$$

20.87 **(a)** A $Cr^{3+}(aq)$ solution is electrolyzed, using a current of 7.60 A. What mass of Cr(*s*) is plated out after 2.00 days? **(b)** What amperage is required to plate out 0.250 mol Cr from a Cr^{3+} solution in a period of 8.00 h?

20.88 Metallic magnesium can be made by the electrolysis of molten $MgCl_2$. **(a)** What mass of Mg is formed by passing a current of 4.55 A through molten $MgCl_2$, for 3.50 days? **(b)** How many minutes are needed to plate out 10.00 g Mg from molten $MgCl_2$, using 3.50 A of current?