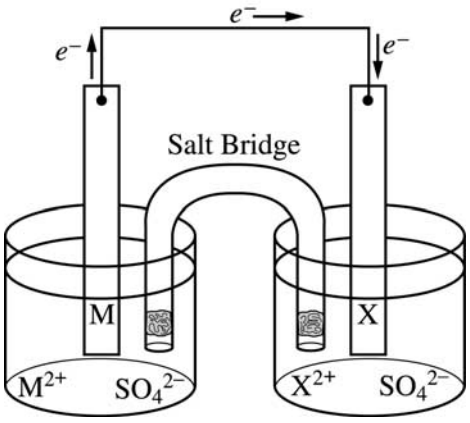
Answer EITHER Question 7 below OR Question 8 printed on page 13. Only one of these two questions will be graded. If you start both questions, be sure to cross out the question you do not want graded. The Section II score weighting for the question you choose is 15 percent.

7. The diagram below shows the experimental setup for a typical electrochemical cell that contains two standard half-cells. The cell operates according to the reaction represented by the following equation.

$$Zn(s) + Ni^{2+}(aq) \rightarrow Ni(s) + Zn^{2+}(aq)$$



(a) Identify M and M^{2+} in the diagram and specify the initial concentration for M^{2+} in solution.

(b) Indicate which of the metal electrodes is the cathode. Write the balanced equation for the reaction that occurs in the half-cell containing the cathode.

(c) What would be the effect on the cell voltage if the concentration of Zn^{2+} was reduced to 0.100 *M* in the half-cell containing the Zn electrode?

(d) Describe what would happen to the cell voltage if the salt bridge was removed. Explain.

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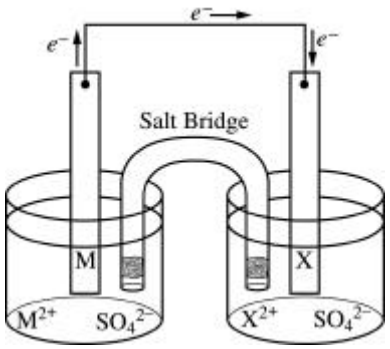
Question 7

8 points

The diagram below shows the experimental setup for a typical electrochemical cell that contains two standard half-cells. The cell operates according to the reaction represented by the following equation.

$$Zn(s) + Ni^{2+}(aq) \rightarrow Ni(s) + Zn^{2+}(aq)$$



(a) Identify M and M^{2+} in the diagram and specify the initial concentration for M^{2+} in solution.

Electrons flow from the anode to the cathode in a voltaic electrochemical cell. The anode is where oxidation occurs, and in the reaction above, Zn(*s*) is oxidized. So, the anode electrode must be Zn (M) and the solution contains Zn^{2+} (M^{2+}). The $[Zn^{2+}] = 1.0$ *M* in a standard cell. Additionally, the reduction potential for the Zn^{2+}/Zn redox couple is less than that for Ni^{2+}/Ni.	1 point earned for correct M and M^{2+} 1 point for the correct concentration of M^{2+} (Zn^{2+})

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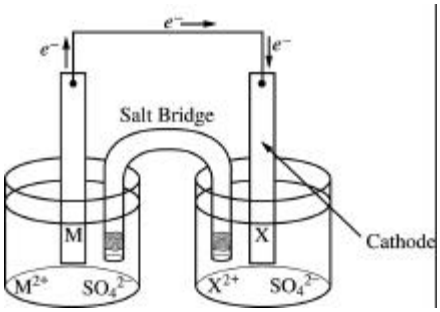
Question 7 (cont'd.)

(b) Indicate which of the metal electrodes is the cathode. Write the balanced equation for the reaction that occurs in the half-cell containing the cathode.

The cathode is Ni(*s*) , indicated by "X"  The half-reaction is $2\ e^- + Ni^{2+} \rightarrow Ni(s)$.	1 point earned for labeling the cathode in the cell diagram 1 point earned for the half-reaction

(c) What would be the effect on the cell voltage if the concentration of Zn^{2+} was reduced to 0.100 *M* in the half-cell containing the Zn electrode?

$E_{cell} = E° - \frac{RT}{nF} \ln \frac{[Zn^{2+}]}{[Ni^{2+}]}$ When the $[Zn^{2+}]$ is lowered to 0.100 *M*, then $Q < 1$. The value of the cell potential under these nonstandard conditions is more positive than $E°$ (under standard conditions). The cell voltage increases. An argument involving LeChâtelier's principle is also acceptable: the decreased $[Zn^{2+}]$ increases the "potential" for the reaction to proceed to the right.	1 point earned for indicating that E_{cell} increases (is larger) 1 point earned for recognizing that $Q < 1$ and/or that the term $\frac{RT}{nF} \ln \frac{[Zn^{2+}]}{[Ni^{2+}]}$ must be added to the $E°$

(d) Describe what would happen to the cell voltage if the salt bridge was removed. Explain.

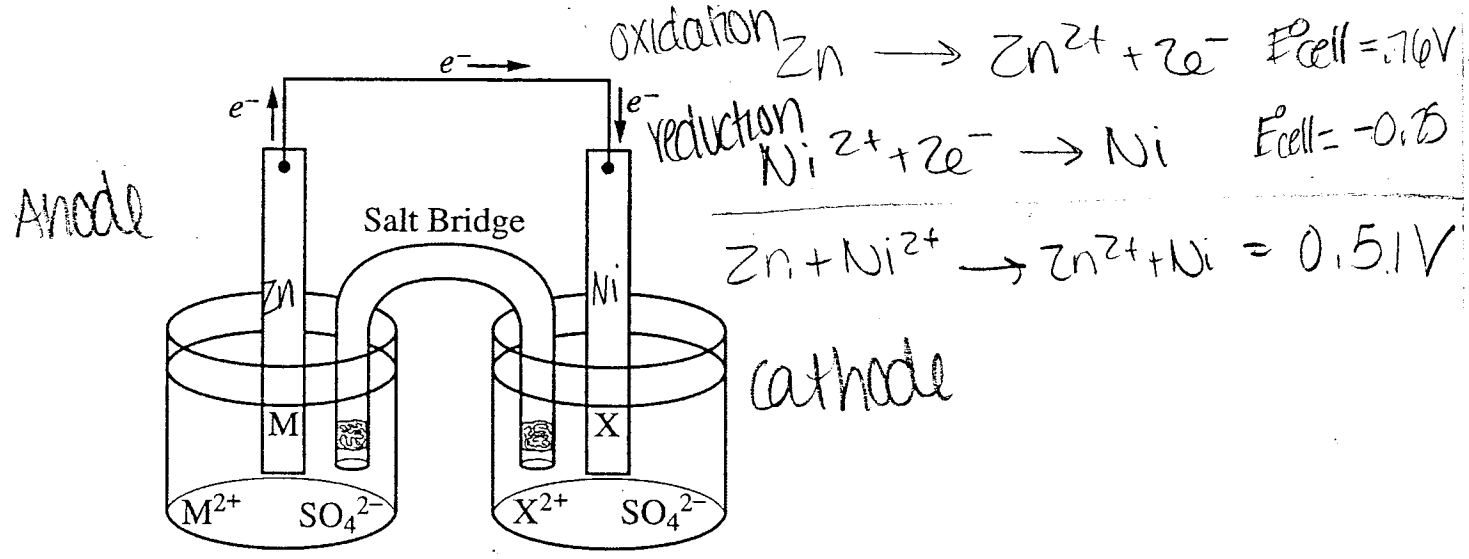
The cell voltage drops to zero when the salt bridge is removed. This happens because the salt bridge is needed to allow charge balance to occur in the solutions the electrodes are immersed in. In the absence of the salt bridge, ions cannot flow to balance the buildup of cations in the anode compartment and the buildup of anions in the cathode compartment.	1 point earned for the effect 1 point earned for the explanation

B B B B B B B B B B B B B 7A,

Answer EITHER Question 7 below OR Question 8 printed on page 22. Only one of these two questions will be graded. If you start both questions, be sure to cross out the question you do not want graded. The Section II score weighting for the question you choose is 15 percent.

7. The diagram below shows the experimental setup for a typical electrochemical cell that contains two standard half-cells. The cell operates according to the reaction represented by the following equation.

$$Zn(s) + Ni^{2+}(aq) \rightarrow Ni(s) + Zn^{2+}(aq)$$



(a) Identify M and M^{2+} in the diagram and specify the initial concentration for M^{2+} in solution.

(b) Indicate which of the metal electrodes is the cathode. Write the balanced equation for the reaction that occurs in the half-cell containing the cathode.

(c) What would be the effect on the cell voltage if the concentration of Zn^{2+} was reduced to 0.100 M in the half-cell containing the Zn electrode?

(d) Describe what would happen to the cell voltage if the salt bridge was removed. Explain.

a) M is the zinc solid and M^{2+} is Zn^{2+} the initial concentration for M^{2+} in the solution is 1M

b) Ni is the cathode. The balanced equation for this reaction at the cathode is:
$Ni^{2+} + 2e^- \rightarrow Ni(s)$

GO ON TO THE NEXT PAGE.

ADDITIONAL PAGE FOR ANSWERING QUESTION 7.

c) The effect on the cell voltage if the concentration of Zn^{2+} was reduced to 0.100M in the half-cell is

According to the Nernst Equation

$E_{cell} = E°_{cell} - \frac{RT}{nF} \ln Q$

$= E°_{cell} - \frac{RT}{nF} \ln \frac{[0.1]}{[Ni^{2+}]}$

0.51V

This part would be a smaller number, thus subtracting less from the $E°_{cell}$ (0.51V), thus making E_{cell} a bigger number than it would have been if the initial concentration of Zn^{2+} was present.

d) The cell voltage would be zero if the salt bridge was removed. This because the salt bridge connects the two half-cells together. The salt bridge is a tube with two porous ends that allows the flow of ions between the two half-cells. Without the salt bridge, their would be no current flowing. There would be a positive build-up in the zinc solution and a negative build-up in the Nickle solution. The salt bridge is needed to overcome the positive and negative build-up and also allow the flow of ions between the two half cells. and to connect the two half-cells together.

GO ON TO THE NEXT PAGE.

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2002 SCORING COMMENTARY (Form B)

Question 7

Sample 7A (Score 8)

Full 8-point credit is earned in this excellent response, which clearly documents the reasoning behind the answers — 2 points for part (a), 2 points for part (b), 2 points for part (c), and 2 points for part (d).

Sample 7B (Score 6)

This response earned a total of 6 points — 1 point for part (a), 2 points for part (b), 2 points for part (c), and 1 point for part (d).

In this good response, parts (b) and (c) earn full credit. In part (a), however, the response does not specify the correct initial concentration of M^{2+} (Zn^{2+}) in solution; in part (d), the response correctly indicates that the voltage would be zero, but falls short in not mentioning ion transfer in the salt bridge.