AP® Chemistry
2002 Sample Student Responses
Form B

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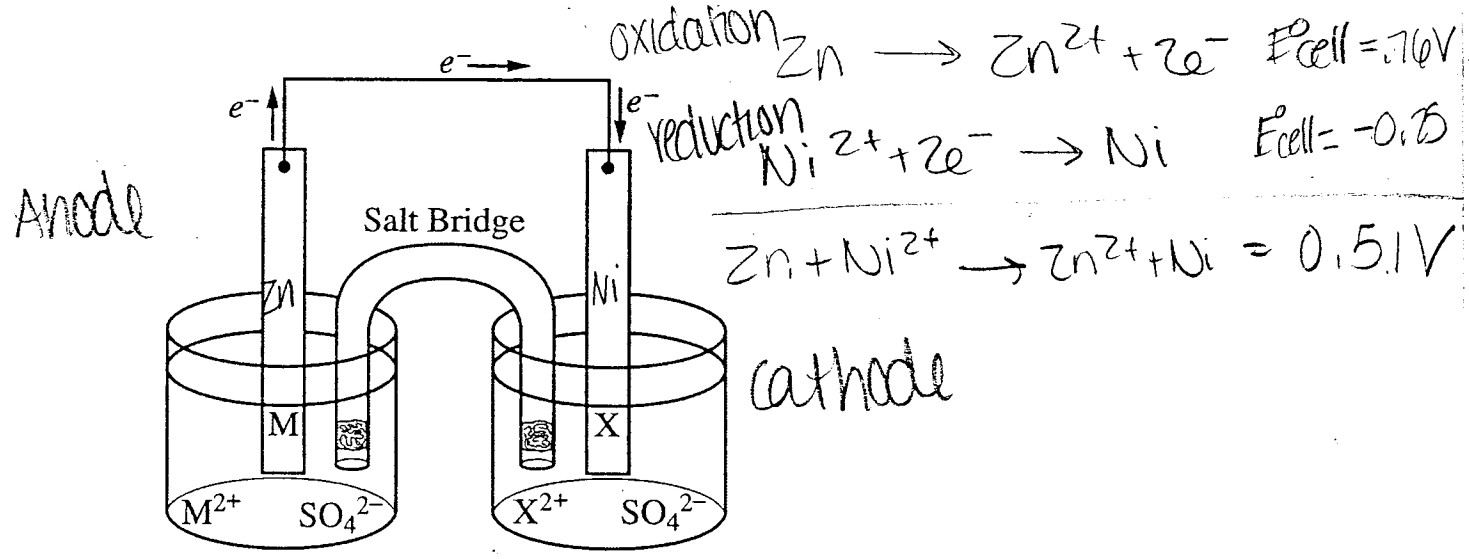
Answer EITHER Question 7 below OR Question 8 printed on page 22. Only one of these two questions will be graded. If you start both questions, be sure to cross out the question you do not want graded. The Section II score weighting for the question you choose is 15 percent.

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.

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B B B B B B B B B B B B B B 7B

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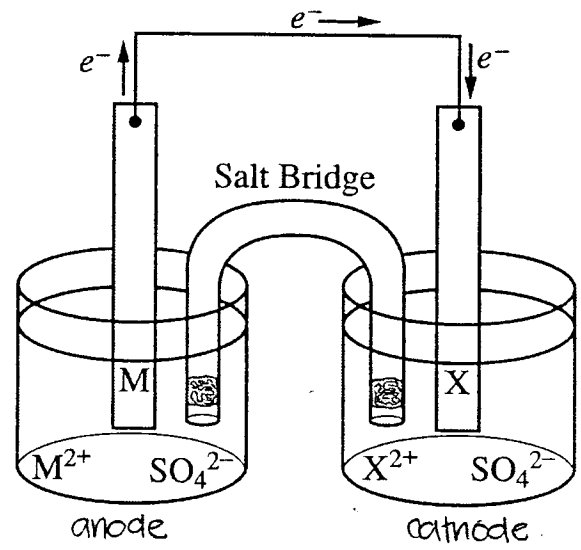

(a) Identify M and M^{2+} in the diagram and specify the initial concentration for M^{2+} in solution.

(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~~ were removed. Explain.

(a) M is Zn M^{2+} is Zn^{2+}

no Zn^{2+} in solution. Zn^{2+} is formed by the Zn electrode.

(b) Ni is the cathode because reduction occurs where the Ni electrode is located.

$Ni^{2+} + 2e^- \rightarrow Ni$

(c) $E = \mathcal{E}^\circ - \frac{0.0592}{n} \log Q$

$Q = \frac{[Zn^{2+}]}{[Ni^{2+}]}$ If the concentration of Zn^{2+} is reduced to 0.1 M, Q of the reaction will decrease. A decrease in Q will cause $\frac{0.0592}{n} \log Q$ to become negative. Therefore $\frac{0.0592}{n} \log Q$ will be added to $\mathcal{E}^\circ$, yielding a greater cell voltage.

GO ON TO THE NEXT PAGE.

ADDITIONAL PAGE FOR ANSWERING QUESTION 7.

(a) There would be no cell voltage if the salt bridge were removed because no reaction will occur. The salt bridge is needed to keep the net charge of the 2 compartments to be zero because if it weren't zero, no electrons will (flow) move. Without a flow of electrons, there will be no cell voltage. V = 0 V.