AP® Chemistry
2001 Sample Student Responses

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7A

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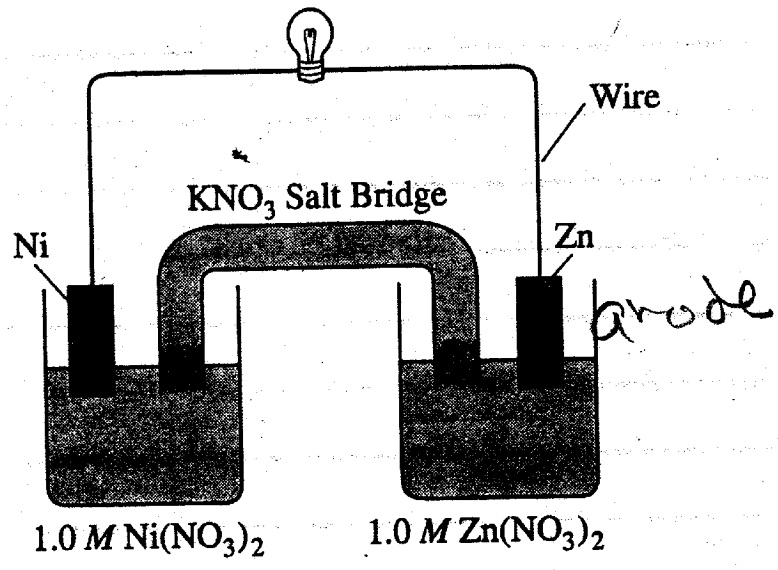
Answer EITHER Question 7 below OR Question 8 printed on page 24. Only one of these two questions will be graded. If you start both questions, be sure to cross out the question you do not want graded. The Section II score weighting for the question you choose is 15 percent.



7. 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 this booklet.)

(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.

(a) $Zn(s) \rightarrow Zn^{2+} + 2e^-$

(b) $Zn(s) + Ni^{2+} + 2e^- \rightarrow Zn^{2+} + 2e^- + Ni(s)$

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

$E^\circ_{cell} = cathode - anode$

$= -.25V - (-.76)$

$= .51\ V$

(c) $E_{cell} = E^\circ_{cell} - \frac{RT}{nF} \ln Q$ ← will increase and E_{cell} will become lower, and less positive

$Q = \frac{[Zn^{2+}]}{[Ni^{2+}]}$ ← decreased then Q increases

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ADDITIONAL PAGE FOR ANSWERING QUESTION 7.

(d) $\log K = \frac{nE^\circ}{.0592}$

$\log K = \frac{2(.51)}{.0592}$

$\log K = \frac{1.02}{.0592}$

K will be larger than 1 since the E° was positive and the inverse log will make a large #

7B

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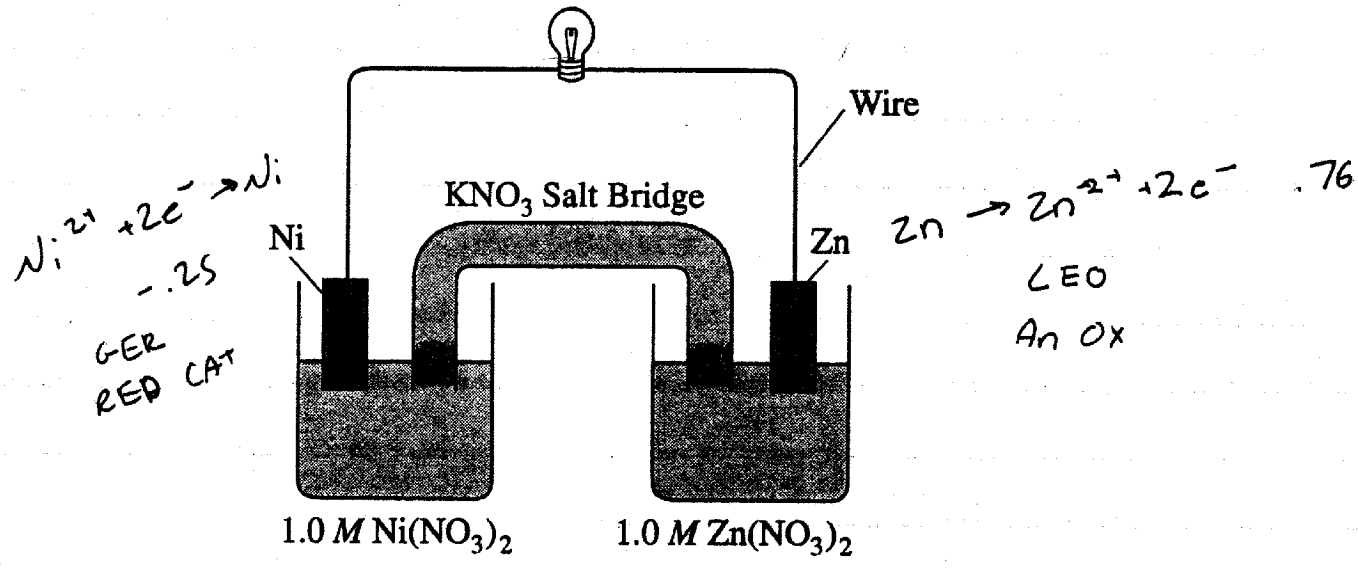

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(d) Specify whether the value of K_{eq} for the cell reaction is less than 1, greater than 1, or equal to 1. Justify your answer.

(a) The zinc metal is the anode. The reaction that occurs there is:
$Zn(s) \rightarrow Zn^{2+} + 2e^-$

(b) $Zn + Ni^{2+} \rightarrow Zn^{2+} + Ni$ $E^\circ_{cell} = .76 - .25 = .51$

(c) $E_{cell} = E^\circ_{cell} - \frac{RT}{nF} \ln Q$ if $\ln Q$ is positive E_{cell} is less than E°_{cell} and if $\ln Q$ is negative, E_{cell} is greater than E°_{cell}

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ADDITIONAL PAGE FOR ANSWERING QUESTION 7.

(D) Keq is greater than 1. Since the voltage is positive the reaction is spontaneous and in the foward reaction, favoring the products

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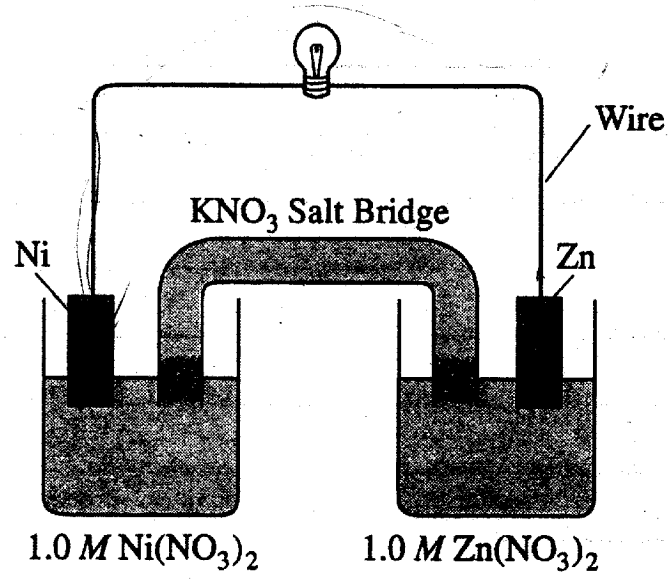

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7. a, Anode = where oxidation occurs, ∴ $Zn(NO_3)_2$ is the anode

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

b, ox. $Zn(s) \rightarrow Zn^{2+} + 2e^-$ $E^\circ cell = .76\ V$

red. $Ni^{2+} + 2e^- \rightarrow Ni(s)$ $E^\circ cell = -.25V$

$Zn(s) + Ni^{2+} \rightarrow Zn^{2+} + Ni(s)$ $E^\circ cell = .51\ V$

ADDITIONAL PAGE FOR ANSWERING QUESTION 7.

c) If $[Ni(NO_3)_2]$ decreases from 1M to .1M, $E°_{cell}$ will decrease.

d) K_{eq} is greater than 1 because the reaction is spontaneous.