AP® Chemistry
2003 Sample Student Responses
Form B

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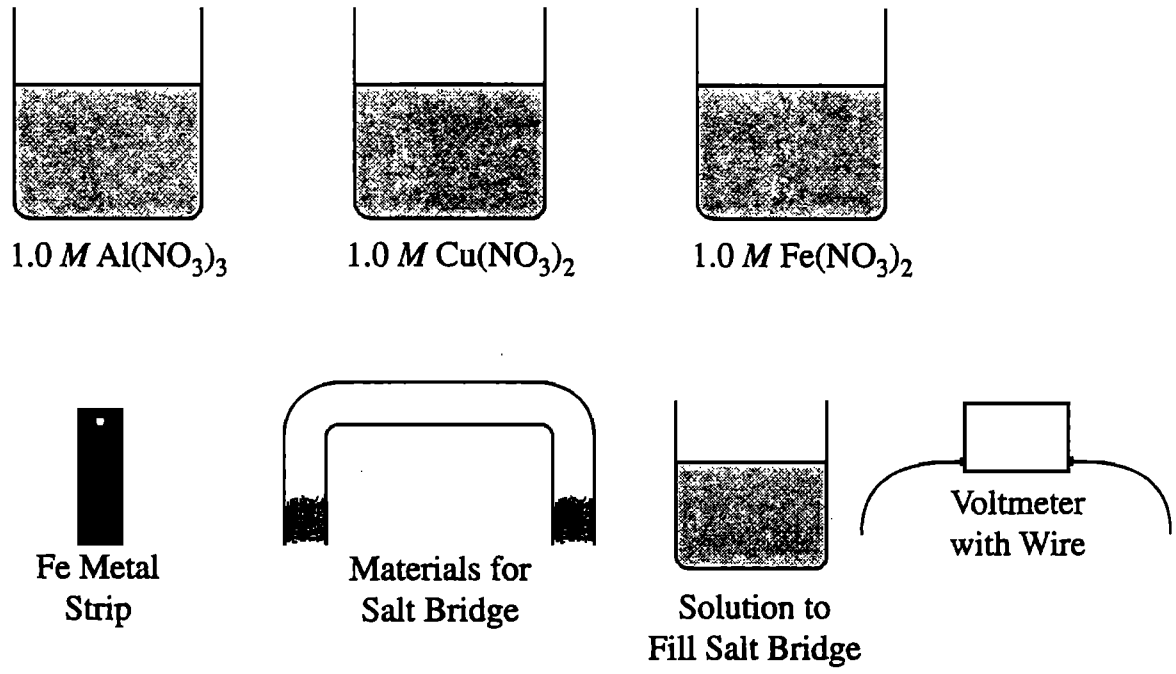
6A

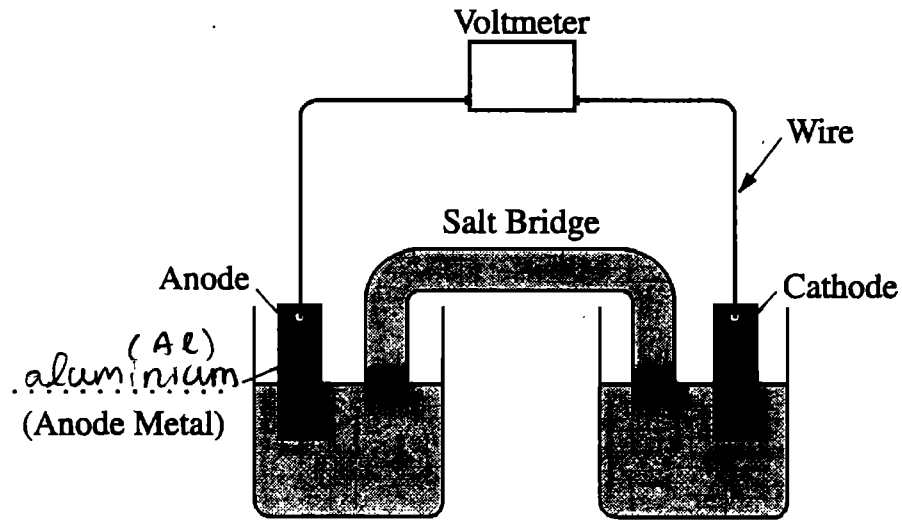
6. Answer the following questions about electrochemistry.

(a) Several different electrochemical cells can be constructed using the materials shown below. Write the balanced net-ionic equation for the reaction that occurs in the cell that would have the greatest positive value of E°_{cell}.



(b) Calculate the standard cell potential, E°_{cell}, for the reaction written in part (a).

(c) A cell is constructed based on the reaction in part (a) above. Label the metal used for the anode on the cell shown in the figure below.



(d) Of the compounds NaOH, CuS, and $NaNO_3$, which one is appropriate to use in a salt bridge? Briefly explain your answer, and for each of the other compounds, include a reason why it is not appropriate.

(e) Another standard cell is based on the following reaction.

$$Zn + Pb^{2+} \rightarrow Zn^{2+} + Pb$$

If the concentration of Zn^{2+} is decreased from 1.0 *M* to 0.25 *M*, what effect does this have on the cell potential? Justify your answer.

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6A2

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ADDITIONAL PAGE FOR ANSWERING QUESTION 6.

a) $2Al_{(s)} + 3Cu^{+2}_{(aq)} \rightarrow 3Cu_{(s)} + 2Al^{+3}_{(aq)}$

b) $E^\circ_{cell} = E^\circ_{ox} + E^\circ_{red} = 1.66 + 0.34 = 2.00\,V$

d) - $NaNO_3$ is appropriate for the salt bridge as neither the Na^+ cation nor the NO_3^- anion shall take part in any reaction with the redox reaction species

- CuS cannot be used as it shall have precipitated to form a black solid and won't be able to allow charge flow to neutralise excess charge build up.

- $NaOH$ cannot be used as it shall be insoluble with Cu^{+2} and Al^{+3} (from ppts) resulting in interference with above redox reaction

e) according to nernst's eq $\Delta E = \Delta E^\circ - \frac{RT}{nF} \ln(Q)$ $Q = \left(\frac{[Zn^{+2}]}{[Pb^{+2}]}\right)$

if $[Zn^+]$ is decreased $\Rightarrow \frac{RT}{nF} \ln Q$ shall be negative

$\Rightarrow \Delta E^\circ + \frac{RT}{nF} \ln Q$ shall increase

$\Rightarrow \Delta E$ shall increase

$\Rightarrow$ cell potential increases

GO ON TO THE NEXT PAGE.

 6B

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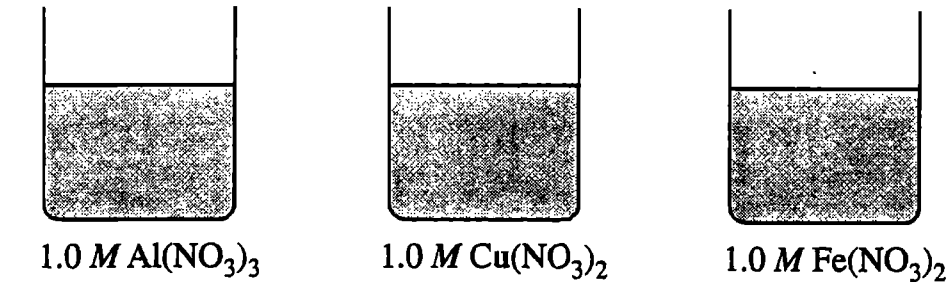

(b) Calculate the standard cell potential, E°_{cell}, for the reaction written in part (a).

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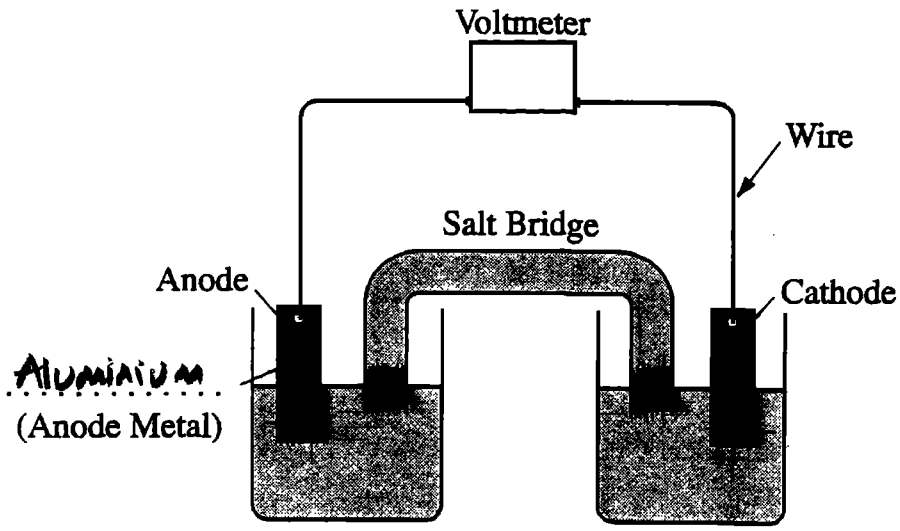

(d) Of the compounds NaOH, CuS, and $NaNO_3$, which one is appropriate to use in a salt bridge? Briefly explain your answer, and for each of the other compounds, include a reason why it is not appropriate.

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If the concentration of Zn^{2+} is decreased from 1.0 *M* to 0.25 *M*, what effect does this have on the cell potential? Justify your answer.

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ADDITIONAL PAGE FOR ANSWERING QUESTION 6.

6(a) $2Al(s) + 3Cu^{2+}(aq) \longrightarrow 2Al^{3+}(aq) + 3Cu(s)$

(b) $E°cell = 0.34 + 1.66$

$= 2.00\ V$

$E°$ cell for Al = 1.66 V as the rxn is reversed

(d) $NaNO_3$ is the most appropriate choice as a salt bridge. NaOH is not suitable as it would precipitate the Al^{3+} ions in the anode compartment. $Al^{3+} + 3OH^- \longrightarrow Al(OH)_3$ CuS is also not a viable option as the salt is insoluble and would defeat the purpose of having the salt bridge. (would not balance the charges in the compartments).

(e) The cell potential will increase according to Le Chatelier's principle.

Decreasing the $[Zn^{2+}]$ will force the rxn to shift to the right which favours the cell potential and increases it.

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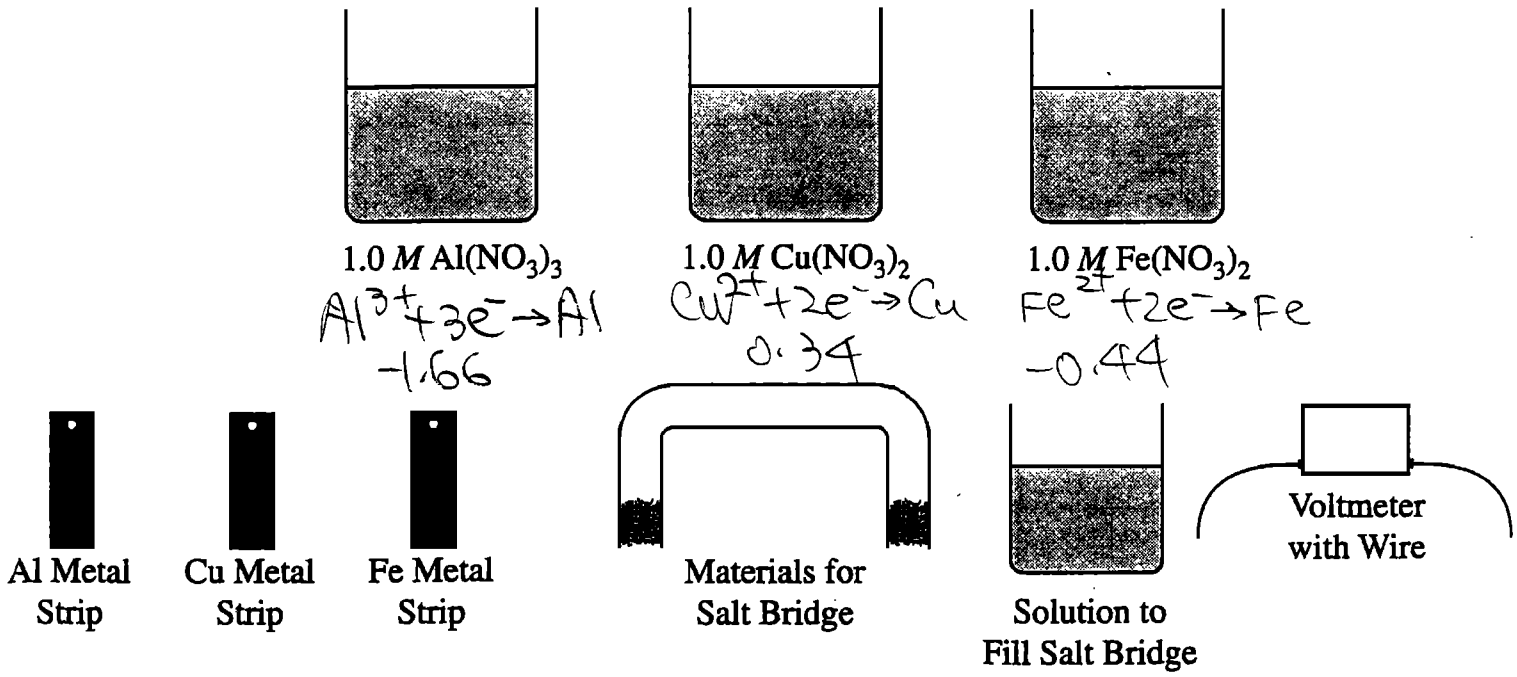
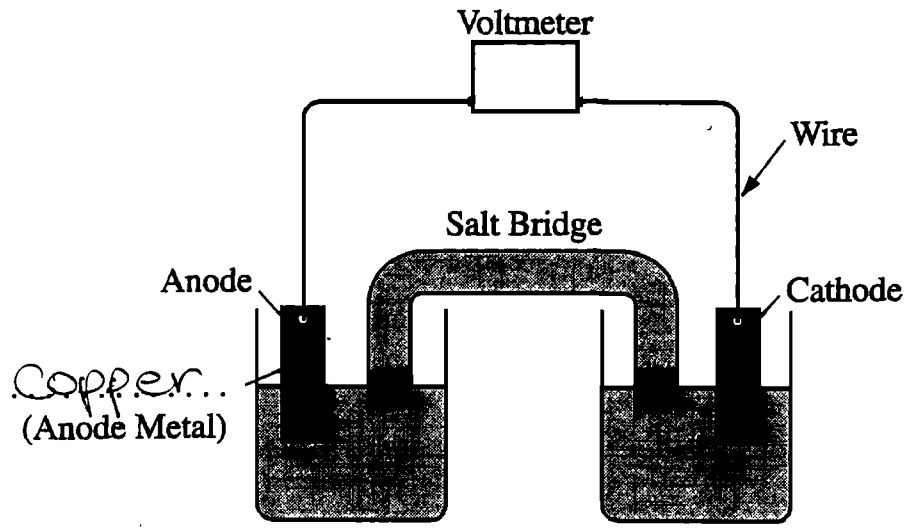


(b) Calculate the standard cell potential, E°_{cell}, for the reaction written in part (a).

(c) A cell is constructed based on the reaction in part (a) above. Label the metal used for the anode on the cell shown in the figure below.



(d) Of the compounds NaOH, CuS, and $NaNO_3$, which one is appropriate to use in a salt bridge? Briefly explain your answer, and for each of the other compounds, include a reason why it is not appropriate.

(e) Another standard cell is based on the following reaction.

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If the concentration of Zn^{2+} is decreased from 1.0 *M* to 0.25 *M*, what effect does this have on the cell potential? Justify your answer.

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B B B B B B B B B B B B B $6C_2$

ADDITIONAL PAGE FOR ANSWERING QUESTION 6.

a) $Al + Cu^{2+} \rightarrow Cu + Al^{3+}$

b) $0.34 + (1.66) = 2$

E° cell $= 2$

c) Anode is for reduction, the gaining of e^-, therefore the anode must be copper

d) $NaNO_3$

- NaOH is not appropriate because the OH^- ion would react with the other metal ions in the solution
- CuS is not appropriate because one of the main chemicals participating in the reaction is copper (Cu) already
- $NaNO_3$ is the most appropriate because the NO_3^- would not affect the reaction and neither would Na^+.

e) The cell potential will increase in order to create a faster forward reaction due to the lost of Zn^{2+} (I a Chatavian's Principle)

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