



AP Chemistry 2000 Student Samples

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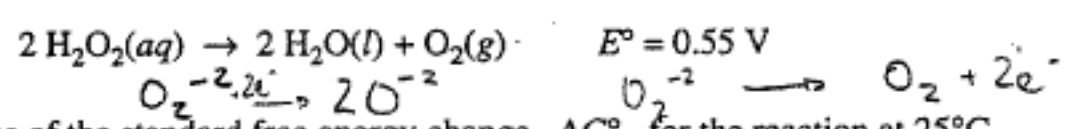
Answer EITHER Question 2 below OR Question 3 printed on page 12. Only one of these two questions will be graded. If you start both questions, be sure to cross out the question you do not want graded. The Section II score weighting for the question you choose is 20 percent.

2. Answer the following questions that relate to electrochemical reactions.

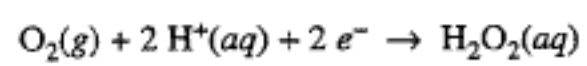
(a) Under standard conditions at 25°C, Zn(s) reacts with Co²⁺(aq) to produce Co(s).

- (i) Write the balanced equation for the oxidation half reaction.
- (ii) Write the balanced net-ionic equation for the overall reaction.
- (iii) Calculate the standard potential, E°, for the overall reaction at 25°C.

(b) At 25°C, H₂O₂ decomposes according to the following equation. ~~O₂ + 4H⁺ + 4e⁻ → 2H₂O~~



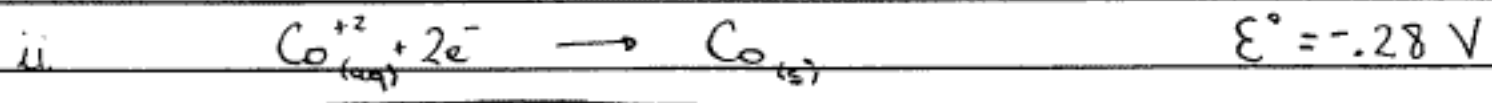
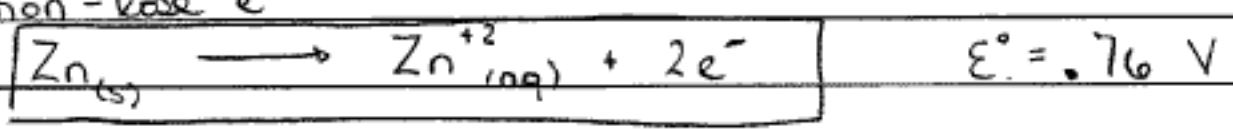
- (i) Determine the value of the standard free energy change, ΔG°, for the reaction at 25°C.
- (ii) Determine the value of the equilibrium constant, K_{eq}, for the reaction at 25°C.
- (iii) The standard reduction potential, E°, for the half reaction O₂(g) + 4 H⁺(aq) + 4 e⁻ → 2 H₂O(l) has a value of 1.23 V. Using this information in addition to the information given above, determine the value of the standard reduction potential, E°, for the half reaction below.



(c) In an electrolytic cell, Cu(s) is produced by the electrolysis of CuSO₄(aq). Calculate the maximum mass of Cu(s) that can be deposited by a direct current of 100. amperes passed through 5.00 L of 2.00 M CuSO₄(aq) for a period of 1.00 hour.

2.)

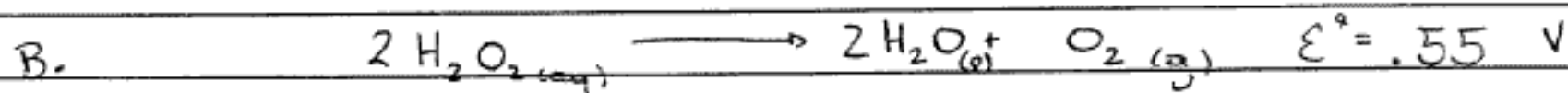
A. i. Oxidation = lose e⁻



iii. $E^\circ_{\text{cell}} = .76 \text{ V} + (-.28 \text{ V})$

$$\boxed{E^\circ_{\text{cell}} = .48 \text{ V}}$$

ADDITIONAL PAGE FOR ANSWERING QUESTION 2.



i. $\Delta G = -n F \mathcal{E}^\circ$ $F = 96485 \frac{\text{C}}{\text{mol } e^-}$
 $= -(2 \text{ mol } e^-)(96485 \frac{\text{C}}{\text{mol } e^-})(.55 \text{ V}) \frac{\text{J}}{\text{C}}$
 $= -106,150 \text{ J}$

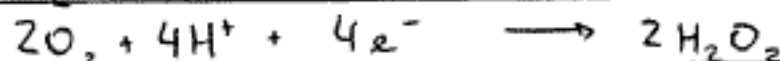
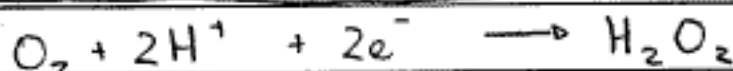
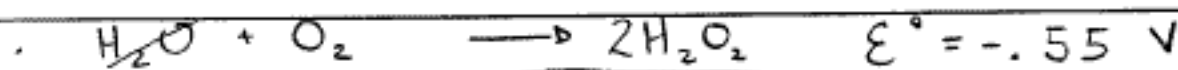
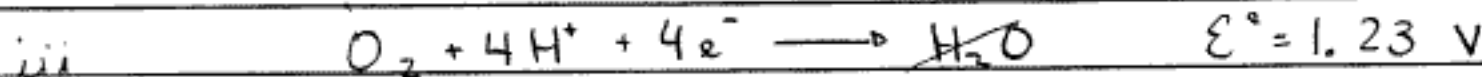
$\Delta G = -110 \text{ kJ}$

ii. $\Delta G = -RT \ln K$

$K_{\text{eq}} = e^{\frac{-\Delta G}{RT}}$

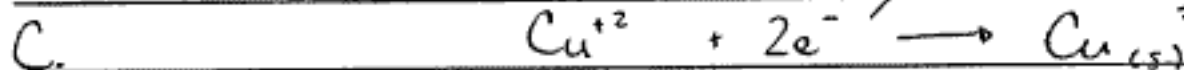
$= e^{\left(\frac{106,150 \text{ J}}{8.315 \frac{\text{J}}{\text{mol} \cdot \text{K}} \cdot 298 \text{ K}}\right)}$

$K_{\text{eq}} = 4.03 \cdot 10^{18}$



$\mathcal{E}^\circ_{\text{rxn}} = 1.23 \text{ V} + (-.55 \text{ V})$

$\mathcal{E}^\circ_{\text{rxn}} = .68 \text{ V}$



$2.00 \frac{\text{mol}}{\text{L}} (5.00 \text{ L}) = 10.0 \text{ mol } \text{Cu}^{2+}$

$A = \frac{\text{C}}{\text{sec}}$

? g Cu = 63.55 g Cu	1 mol Cu	mol e ⁻	100. C	60 sec	60 min	1.00 hr
mol Cu	2 mol e ⁻	96485 C	sec	1 min	1 hr	

$= 119 \text{ g Cu}$

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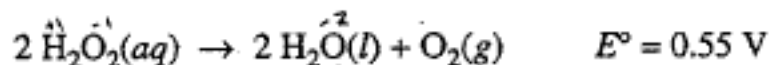
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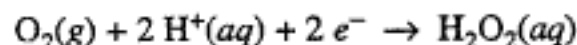
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- (i) Write the balanced equation for the oxidation half reaction.
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(b) At 25°C, H₂O₂ decomposes according to the following equation.



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(c) In an electrolytic cell, Cu(s) is produced by the electrolysis of CuSO₄(aq). Calculate the maximum mass of Cu(s) that can be deposited by a direct current of 100. amperes passed through 5.00 L of 2.00 M CuSO₄(aq) for a period of 1.00 hour.

2) i) $\text{Zn} \rightarrow \text{Zn}^{2+} + 2e^-$

ii) $\text{Zn} + \text{Co}^{2+} \rightarrow \text{Zn}^{2+} + \text{Co}$

iii) $E^\circ_{\text{ox Zn}} = .76$

$E^\circ_{\text{red Co}} = -.28$

$E^\circ = .76 + -.28 = .48 \text{ V}$

3) i) $\Delta G^\circ = -nFE^\circ$

$\Delta G^\circ = -(1)(96500)(.55)$

$= -53075$

ii) $\Delta G^\circ = -2.303RT \log K$

$-53075 = -2.303(8.31)(298) \log K$

$\log K = 9.306$

$K = 2.02 \times 10^9$

GO ON TO THE NEXT PAGE.

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RING QUESTION 2.

ii) $E^\circ = 1.23 + (-.55) = .68 \text{ V}$

c) $M = \frac{\text{mol}}{\text{V}}$

100	60.60		96500		20 e ⁻		63.55 = 11.85 g
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$2.00 = \frac{\text{mol}}{5}$

mol = 10

10 mol \rightarrow 20 e⁻

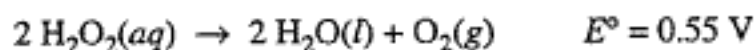
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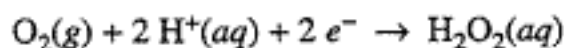
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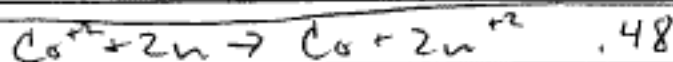
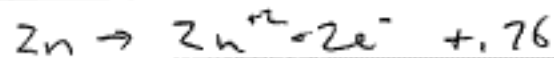
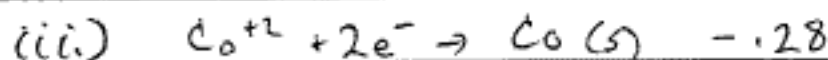
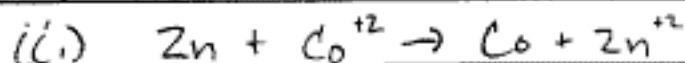
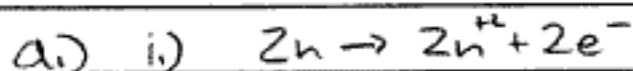
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$$E^\circ = .48 \text{ V}$$

~~9707~~

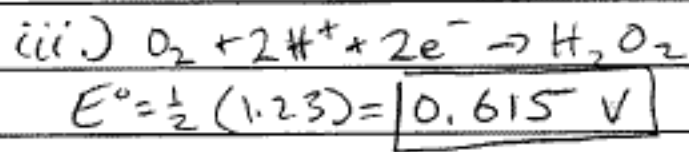
ADDITIONAL PAGE FOR ANSWERING QUESTION 2.

$$b.) \quad (i) \quad \Delta G = -nFE^\circ$$

$$= -2(96,500)(0.55V)$$

$$\boxed{\Delta G = -1.06 \times 10^5}$$

$$(ii) \quad K_{eq} = \frac{[H_2O]^2 [O_2]}{[H_2O_2]^2}$$



c.)