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Pre-Lab Assignment: Electrochemical Cells Experiment

Answer each of the following questions and place the responses on the lines provided.

1. The following data were measured using a nickel electrode as the standard:

$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	0.62 V
$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$	0.00 V
$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$	–0.15 V
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	–1.38 V

A. Which ion is most easily reduced?

_____

B. Which metal is most easily oxidized?

_____

C. The copper and aluminum electrodes are connected in a battery.

1) Which is the anode? cathode?

Anode: _____ Cathode: _____

2) Which is oxidized? reduced?

Oxidized: _____ Reduced: _____

3) What will the battery voltage be?

_____

4) Write a balanced net ionic equation for the reaction that takes place.

_____

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Experiment

Part 1A**:** E^o for: Zn | 1.0 M Zn^{+2} || 1.0 M Cu^{+2} | Cu

Theoretical: _____ V Experimental: _____ V

Part 1B**:** E_{cell} for: Zn | 0.10 M Zn^{+2} || 1.0 M Cu^{+2} | Cu

Theoretical: _____ V Experimental: _____ V

Part 1C**:** E_{cell} for: Zn | 1.0 M Zn^{+2} || 0.10 M Cu^{+2} | Cu

Theoretical: _____ V Experimental: _____ V

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Part 2: $\boldsymbol{E}^{o}$ and $\mathbf{K}_{sp}$ for: $Cu|Cu(OH)_2$ in 1.0 M OH^- || 1.0 M Cu^{2+} | Cu

Experimental $\boldsymbol{E^o}$ = _____ V

Calculate experimental **K**sp using experimental $\boldsymbol{E}^{o}$ and the Nernst equation at equilibrium.

Experimental K_{sp} = _____

Calculate the theoretical $\boldsymbol{E}^{o}$ using a literature value for **K**sp = 2.2×10^{-20}.

Theoretical $\boldsymbol{E^o}$ = _____ V

Calculate the % error in $\boldsymbol{E}^{o}$.

% error in $\boldsymbol{E}^{o}$ = _____

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Part 3: $\boldsymbol{E}^{o}$ and $\mathbf{K}_f$ for: $Cu|Cu(NH_3)_4^{2+}$ in 1.0 M NH_3 || 1.0 M $Cu^{2+}|Cu$

Experimental $\boldsymbol{E^o}$ = _____ V

Calculate experimental $\mathbf{K_f}$ using experimental $\boldsymbol{E}^{o}$ and the Nernst equation at equilibrium.

Experimental K_f = _____

Calculate the theoretical $\boldsymbol{E}^{o}$ using a literature value for $\mathbf{K}_f = 1.7 \times 10^{13}$.

Theoretical $\boldsymbol{E^o}$ = _____ V

Calculate the % error in $\boldsymbol{E}^{o}$.

% error in $\boldsymbol{E}^{o}$ = _____

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Post-Lab Questions:

1. Sketch and label well with movement arrows the processes occurring in the standard Daniell cell (from Part 1A) while it is operating. Note that the electrode reactions produce and consume ions at the electrodes.

2. Briefly comment on how well your experimental cell potentials match the theoretical cell potentials in the standard and nonstandard Daniell cells from parts 1A/1B/1C.

3. How should the voltage change in the Daniell cell if the zinc solution is made more dilute (and the concentration of the copper solution is kept the same)? Explain your choice.

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4. Calculate the solubility product of silver chloride, an extremely insoluble salt, from the following oxidation potentials:

$Ag \rightarrow Ag^+ + e^-$ $\quad\quad$ $\boldsymbol{E}^o = -0.7996$ V

$Ag + Cl^- \rightarrow AgCl + e^-$ $\quad\quad$ $\boldsymbol{E}^o = -0.2221$ V

5. Construct a standard voltaic cell diagram that will enable you to determine the solubility product of AgCl from the half reactions given in the previous question.

6. A cell that has the following half reactions was constructed.

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

$Cd + 3\,en \rightarrow Cd(en)_3^{2+} + 2e^-$

The measured $\boldsymbol{E}^o$ at 25 ^oC was +0.38 V. Calculate the experimental K_f.