Name _____ Date _____ Period _____

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# 9.9 Cell Potential and Free Energy

AP Chemistry

Show your work with units. $E°_{cell} = E°_{cathode} - E°_{anode}$ and $\Delta G° = -nFE°$, with F = 96,485 C/mol $e^-$ and 1 V = 1 J/C.

**1.** Use the table of standard reduction potentials for this worksheet. For $Mg(s) + Cu^{2+}(aq) \rightarrow Mg^{2+}(aq) + Cu(s)$:

| Half-reaction | E° (V) | Half-reaction | E° (V) |
|---|---|---|---|
| $Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$ | +1.36 | $Ag^+(aq) + e^- \rightarrow Ag(s)$ | +0.80 |
| $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ | +0.34 | $Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$ | −0.13 |
| $Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$ | −0.44 | $Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$ | −0.76 |
| $Al^{3+}(aq) + 3e^- \rightarrow Al(s)$ | −1.66 | $Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$ | −2.37 |

(a) Identify the anode and cathode and calculate $E°_{cell}$. (b) Find n and calculate $\Delta G°$.

**2.** Is $2Ag(s) + Zn^{2+}(aq) \rightarrow 2Ag^+(aq) + Zn(s)$ thermodynamically favored under standard conditions? Justify with $E°_{cell}$ and the sign of $\Delta G°$.


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**3.** For $Fe(s) + 2Ag^{+}(aq) \rightarrow Fe^{2+}(aq) + 2Ag(s)$, a student writes $E°_{cell} = 2(+0.80) - (-0.44) = +2.04$ V. Find the error and give the correct $E°_{cell}$.

**4.** For $2Al(s) + 3Cu^{2+}(aq) \rightarrow 2Al^{3+}(aq) + 3Cu(s)$, find $E°_{cell}$, the number of electrons transferred, n, and $\Delta G°$.

**5.** Use the table. (a) Which species is the strongest oxidizing agent? The strongest reducing agent? (b) Will Cu(s) react with $Fe^{2+}(aq)$ under standard conditions? Justify with $E°_{cell}$.


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