

Galvanic Cells and Electrode Potentials

Cell potentials, cell notation, ΔG° and electrolysis

Name _____ Class _____ Date _____

STANDARD REDUCTION POTENTIALS (25 °C) AND CONSTANTS

$F_2/F^- +2.87\text{ V} \cdot Ag^+/Ag +0.80\text{ V} \cdot Cu^{2+}/Cu +0.34\text{ V} \cdot 2H^+/H_2 0.00\text{ V} \cdot Ni^{2+}/Ni -0.25\text{ V} \cdot Zn^{2+}/Zn -0.76\text{ V} \cdot Mg^{2+}/Mg -2.37\text{ V}$

$$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} \cdot \Delta G^\circ = -nFE^\circ_{\text{cell}} \cdot Q = It \cdot n(e^-) = Q/F$$

$$F = 96\,485\text{ C/mol} \cdot 1\text{ C} \times 1\text{ V} = 1\text{ J} \cdot 1\text{ A} = 1\text{ C/s} \cdot Cu = 63.55\text{ g/mol} \cdot Ag = 107.87\text{ g/mol}$$

Show units in every step.

A. Understanding

1. In a galvanic cell, state what happens at the anode and the cathode, which way electrons flow through the wire, and the role of the salt bridge.

B. Cell potentials

2. A cell is made from Zn^{2+}/Zn and Ag^+/Ag half-cells. (a) Identify the anode and the cathode. (b) Calculate E°_{cell} . (c) Write the overall equation. (d) Write the cell notation.

3. Calculate E°_{cell} for a cell made from Ni^{2+}/Ni and Ag^+/Ag half-cells, and state which metal is the anode.

4. Calculate E°_{cell} for a magnesium–copper cell.

5. Use E°_{cell} to decide whether each reaction is spontaneous: (a) $\text{Cu} + \text{Zn}^{2+} \longrightarrow \text{Cu}^{2+} + \text{Zn}$ (b) $\text{Zn} + 2 \text{H}^+ \longrightarrow \text{Zn}^{2+} + \text{H}_2$

6. From the data, identify the strongest oxidizing agent and the strongest reducing agent.

C. Free energy

7. Calculate ΔG° for the Daniell cell, $\text{Zn} + \text{Cu}^{2+} \longrightarrow \text{Zn}^{2+} + \text{Cu}$.

D. Electrolysis

8. A spoon is silver-plated using a current of 1.50 A for 45.0 min ($\text{Ag}^+ + \text{e}^- \longrightarrow \text{Ag}$). What mass of silver is deposited?

E. Challenge

9. How long, in minutes, must a current of 3.00 A flow through copper(II) sulfate solution to deposit 5.00 g of copper ($\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$)?