

Concentration Cells, Externally Powered Models, and Energy Efficiency

g11_u05_w19

Purpose and boundary

Use supplied original fictional paper-data models only. No cells, circuits, electrolysis, solutions, gases, materials, or device operation are requested.

Targets: I can use a stated concentration model to calculate a potential difference, compare system energy quantities, and limit an efficiency claim to its evidence. **Vocabulary:** concentration cell, reaction quotient, external work, electrical energy, theoretical amount, efficiency. **Prerequisites:** logarithms, Faraday's law, half-reactions, system boundaries.

For this packet use $E = (0.05916/n) \log_{10}(C_{\text{high}}/C_{\text{low}})$ at the stated 25°C model condition, $F = 96\,485 \text{ C mol}^{-1} \text{ e}^{-}$, and $|\Delta G| = nFE$. All values are fictional and are not device-performance claims.

1. Define a concentration cell in terms of a difference in stated conditions.

2. In the supplied equation, what does n represent?

3. Why must both the temperature condition and the concentration ratio be stated?

4. For a two-electron model with $C_{\text{high}} = 1.00 \text{ M}$ and $C_{\text{low}} = 0.0100 \text{ M}$, find E .

5. Repeat item 4 for $C_{\text{high}} = 0.100 \text{ M}$ and $C_{\text{low}} = 0.0100 \text{ M}$.

6. Compare the two magnitudes in items 4–5. Which has the larger modeled driving difference?

7. Explain why a concentration difference tending toward equality makes the stated model potential tend toward zero.

8. For item 4, calculate $|\Delta G|$ per stated reaction amount using $n = 2$.

9. State the units in nFE and identify why the result is energy rather than power.

10. Distinguish a positive modeled cell potential from a guarantee of current, lifetime, or safety.

11. A fictional externally powered paper model transfers $Q = 1200$ C. Find mol e^- .
-
12. A listed product model needs 2 mol e^- per mol product. Find the theoretical mol product from item 11.
-
13. Explain the difference between a spontaneous-cell model and an externally powered model without describing an apparatus.
-
14. A paper record lists 0.00622 mol theoretical product and 0.00480 mol assigned product. Find the assigned/theoretical percentage.
-
15. Give one supported statement and one unsupported statement from item 14.
-
16. Name one missing measurement that prevents item 14 from establishing an energy efficiency.
-
17. A data card reports $E = 0.0300$ V and $Q = 250.$ C. Find the modeled electrical-energy magnitude EQ .
-
18. Explain why EQ from item 17 is not enough to determine a full system energy balance.
-
19. A student changes $C_{\text{high}}/C_{\text{low}}$ from 100 to 10 and says the potential is divided by 10. Correct the claim with logarithm reasoning.
-
20. Write a two-sentence bounded conclusion for a fictional record that reports a 77.2% amount comparison and no energy-input measurement.
-