Electrochemistry Numericals Practice Sheet

12 board-style questions across the five types. Take F = 96487 C mol^{-1} unless stated; 2.303RT/F = 0.059 V at 298 K. Answers on page 2.

#	Type	Question	My answer
1	Nernst	Calculate the EMF at 298 K of Zn | Zn^{2+} (0.1 M) || Cu^{2+} (0.001 M) | Cu. $E°_{cell}$ = 1.10 V.	
2	Nernst	Find the EMF of Ni | Ni^{2+} (0.01 M) || Ag^{+} (0.1 M) | Ag at 298 K. $E°(Ni^{2+}/Ni) = -0.25$ V, $E°(Ag^{+}/Ag) = 0.80$ V.	
3	Nernst	Calculate the electrode potential of Ag^{+}/Ag in 0.001 M Ag^{+} at 298 K. E° = 0.80 V.	
4	Gibbs / K	For $Cu(s) + 2Ag^{+}(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$, $E°_{cell}$ = 0.46 V. Calculate $\Delta_r G°$.	
5	Gibbs / K	Calculate the equilibrium constant for the reaction in Q4 at 298 K.	
6	Conductivity	A conductivity cell filled with KCl solution (κ = 0.00141 S cm^{-1}) has a resistance of 1000 Ω. Find the cell constant.	
7	Conductivity	The conductivity of 0.1 M KCl is 0.0129 S cm^{-1}. Calculate its molar conductivity.	
8	Kohlrausch	Using $\lambda°(Ca^{2+})$ = 119.0 and $\lambda°(Cl^{-})$ = 76.3 S cm^2 mol^{-1}, calculate $\Lambda°_m$ for $CaCl_2$.	
9	Kohlrausch	Λ_m of 0.01 M acetic acid is 16.3 S cm^2 mol^{-1}. Using $\lambda°(H^{+})$ = 349.6 and $\lambda°(CH_3COO^{-})$ = 40.9, find α and Ka.	
10	Faraday	A current of 2 A is passed through $CuSO_4$ solution for 965 s. What mass of copper is deposited? (Cu = 63.5, F = 96500 C mol^{-1})	
11	Faraday	How long must a current of 1.0 A flow to deposit 1.08 g of silver from $AgNO_3$? (Ag = 108, F = 96500 C mol^{-1})	
12	Faraday	How much charge, in coulombs, is needed to produce 1 mol of Al from molten Al_2O_3?	

Answers and key steps

#	Answer
1	$n = 2$; $E = 1.10 - 0.0295 \log(0.1/0.001) = 1.10 - 0.059 = 1.041$ V
2	$E°cell = 0.80 - (-0.25) = 1.05$ V; $n = 2$; $Q = [Ni^{2+}]/[Ag^{+}]^2 = 0.01/0.01 = 1$, so $E = 1.05$ V
3	$E = 0.80 - 0.059 \log(1/0.001) = 0.80 - 0.177 = 0.623$ V
4	$\Delta rG° = -2 \times 96487 \times 0.46 = -88{,}768$ J mol^{-1} ≈ -88.77 kJ mol^{-1}
5	$\log K = 2 \times 0.46/0.059 = 15.59$, so $K \approx 3.9 \times 10^{15}$
6	$G^* = \kappa R = 0.00141 \times 1000 = 1.41$ cm^{-1}
7	$\Lambda m = 0.0129 \times 1000/0.1 = 129$ S cm^2 mol^{-1}
8	$\Lambda°m = 119.0 + 2(76.3) = 271.6$ S cm^2 mol^{-1}
9	$\Lambda°m = 390.5$; $\alpha = 16.3/390.5 = 0.0417$; $Ka = 0.01(0.0417)^2/(1 - 0.0417) \approx 1.82 \times 10^{-5}$ mol L^{-1}
10	$Q = 2 \times 965 = 1930$ C $= 0.02$ mol $e^- \rightarrow 0.01$ mol Cu $= 0.635$ g
11	1.08 g Ag $= 0.01$ mol, needs 0.01 mol $e^- = 965$ C; $t = 965/1.0 = 965$ s
12	$Al^{3+} + 3e^- \rightarrow Al$: 3 mol $e^- = 3 \times 96487 = 289{,}461$ C ($\approx 2.89 \times 10^5$ C)

Score tracker

Type	Questions	Correct	Mistake I made
Nernst	1–3		
Gibbs / K	4–5		
Conductivity	6–7		
Kohlrausch	8–9		
Faraday	10–12		