ANSWER KEY.

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9.11 Electrolysis and Faraday's Law

AP Chemistry | ANSWER KEY

Show your work with units. Use q = It, 1 A = 1 C/s, and F = 96,485 C/mol e^-. Time must be in seconds.

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1. A current of 3.00 A runs through a Ni^{2+} solution for 45.0 min. What mass of Ni (58.69 g/mol) is deposited?

t = (45.0 min)(60 s/min) = 2,700 s; q = It = (3.00 C/s)(2,700 s) = 8,100 C

mol e^- = 8,100 C / (96,485 C/mol e^-) = 0.08395 mol; mol Ni = 0.08395 / 2 = 0.04198 mol

mass = (0.04198 mol)(58.69 g/mol) = **2.46 g Ni**

2. How many minutes does it take to deposit 1.50 g of Zn (65.38 g/mol) from Zn^{2+}(aq) with a current of 4.00 A?

mol Zn = 1.50 g / 65.38 g/mol = 0.02294 mol; mol e^- = 2(0.02294) = 0.04589 mol

q = (0.04589 mol e^-)(96,485 C/mol e^-) = 4,427 C; t = q / I = 4,427 C / 4.00 A = 1,107 s

t = 1,107 s / 60 = **18.4 min**

3. A part is chrome-plated from a Cr^{3+} solution. What current is needed to deposit 0.750 g of Cr (52.00 g/mol) in 20.0 min?

mol Cr = 0.750 g / 52.00 g/mol = 0.01442 mol; mol e^- = 3(0.01442) = 0.04327 mol

q = (0.04327)(96,485) = 4,175 C; t = (20.0 min)(60 s/min) = 1,200 s

I = q / t = 4,175 C / 1,200 s = **3.48 A**

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4. Two electrolytic cells are connected in series, so the same charge passes through both. One holds $AgNO_3(aq)$ and the other holds $CuSO_4(aq)$. When 1.08 g of Ag (107.87 g/mol) deposits in the first cell, what mass of Cu (63.55 g/mol) deposits in the second?

mol Ag = 1.08 g / 107.87 g/mol = 0.01001 mol = mol e^- ($Ag^+ + e^- \rightarrow Ag$)

mol Cu = 0.01001 / 2 = 0.005006 mol ($Cu^{2+} + 2e^- \rightarrow Cu$); mass = (0.005006 mol)(63.55 g/mol) = **0.318 g Cu**

5. Molten NaCl is electrolyzed with a current of 10.0 A for 1.00 h.

(a) Write the half-reactions at the anode and cathode. (b) What mass of $Cl_2(g)$ (70.90 g/mol) forms? (c) Why is a power source needed?

(a) **Anode: $2Cl^- \rightarrow Cl_2(g) + 2e^-$. Cathode: $Na^+ + e^- \rightarrow Na(l)$.**

(b) q = (10.0 C/s)(3,600 s) = 36,000 C; mol e^- = 0.3731; mol Cl_2 = 0.1866; mass = **13.2 g Cl_2**

(c) **The reaction $2NaCl(l) \rightarrow 2Na(l) + Cl_2(g)$ is thermodynamically unfavored** ($\Delta G° > 0$: Na and Cl_2 react very favorably to form NaCl, so the reverse is very unfavored). Outside energy must drive it.

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