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CHEMISTRY WORKSHEET

ELECTROLYSIS

Course: SCH4U Grade 12 Chemistry

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50 Practice Problems with Answers and Detailed Solutions

FULL worksheet contains 50 representative problems on:

✓ Faraday's law, ✓ charge-current-time calculations, ✓ molten salt electrolysis, ✓ aqueous electrolysis product prediction, ✓ gas volumes at SATP, ✓ electroplating mass and thickness, ✓current efficiency, ✓ concentration changes, ✓ cells in series, ✓ electrorefining, ✓ integrated industrial-style problems

All problems are designed to reflect style and difficulty commonly seen on quizzes, tests, and final exams. Detailed solutions are included to help students understand the reasoning behind every step.

PART A - FUNDAMENTAL PROBLEMS Problems 1-15. Simple calculations and basic applications	**PART B - INTERMEDIATE PROBLEMS** Problems 16-30. Typical unit test questions involving multiple steps
PART C - ADVANCED PROBLEMS Problems 31-40. More challenging calculations requiring deeper understanding	**PART D - CHALLENGE PROBLEMS** Problems 41-50. Difficult exam-style questions combining multiple concepts

SUITABLE FOR:
quizzes, unit tests and final exam preparation

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Section 1 - Essential Information

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Section 2 - Practice Problems

Part A - Fundamental Problems

Problem 8 What volume of O_2 gas is produced at SATP when 0.400 mol e^- is transferred at an inert anode

Part B - Intermediate Problems

Problem 16 A Ni^{2+} solution is electrolyzed using a current of 4.50 A for 45.0 min. Calculate the mass of Ni plated

Part C - Advanced Problems

Problem 32 A Ni^{2+} solution is electrolyzed at 5.00 A for 30.0 min. The actual mass of Ni plated is 2.30 g. Calculate the percent current efficiency

Part D - Challenge Problems

Problem 45 A molten Al_2O_3 cell operates at 1.50×10^4 A for 8.00 h at 4.50 V. If aluminum production is 95.0% efficient, calculate the mass of Al produced and the electrical energy used in kWh

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Solutions

Problem 8 Solution

Given: $n(e^-)$ = 0.400 mol and the molar volume at SATP is 24.8 L/mol.

Find: The volume of oxygen gas produced at an inert anode.

Oxidation of water releases four electrons for every mole of O_2 formed.

$$2H_2O_{(l)} \rightarrow O_{2(g)} + 4H^+_{(aq)} + 4e^-$$

$$n(O_2) = 0.400 \text{ mol } e^- \div 4 = 0.100 \text{ mol}$$

$$V(O_2) = (0.100 \text{ mol})(24.8 \text{ L/mol}) = 2.48 \text{ L}$$

Final answer: 2.48 L of O_2 is produced.

Problem 16 Solution

Given: I = 4.50 A, t = 45.0 min, and M(Ni) = 58.69 g/mol.

Find: The mass of nickel plated.

The current and time determine the charge passed. The time is first converted to seconds.

$$Q = I \cdot t = (4.50 \text{ A})(45.0 \text{ min} \cdot 60 \text{ s/min}) = 1.215 \times 10^4 \text{ C}$$

$$n(e^-) = Q/F = 1.215 \times 10^4 \text{ C} \div 96\,485 \text{ C/mol} = 0.1259 \text{ mol } e^-$$

Nickel(II) requires two electrons per mole of Ni.

$$Ni^{2+}_{(aq)} + 2e^- \rightarrow Ni_{(s)}$$

$$n(Ni) = 0.1259/2 = 0.06296 \text{ mol}$$

$$m(Ni) = (0.06296 \text{ mol})(58.69 \text{ g/mol}) = 3.70 \text{ g}$$

Final answer: 3.70 g of Ni is plated.

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Problem 32 Solution

Given: $I = 5.00$ A, $t = 30.0$ min, and the actual nickel mass is 2.30 g.

Find: The percent current efficiency.

The theoretical deposit is based on all of the current producing Ni.

$$Q = (5.00\ \text{A})(30.0\ \text{min} \cdot 60\ \text{s/min}) = 9000\ \text{C}$$

$$n(e^-) = 9000/96\,485 = 0.0933\ \text{mol}\ e^-$$

$$Ni^{2+}_{(aq)} + 2e^- \rightarrow Ni_{(s)}$$

$$n(Ni)_{theoretical} = 0.0933/2 = 0.0466\ \text{mol}$$

$$m(Ni)_{theoretical} = (0.0466\ \text{mol})(58.69\ \text{g/mol}) = 2.74\ \text{g}$$

Current efficiency compares the actual deposit with the theoretical deposit.

$$\text{efficiency} = (2.30\ \text{g}/2.74\ \text{g}) \cdot 100\% = 84.0\%$$

Final answer: The current efficiency is 84.0%.

Problem 45 Solution

Given: $I = 1.50 \times 10^4$ A, t = 8.00 h, cell voltage = 4.50 V, and aluminum-production efficiency = 95.0%.

Find: The mass of Al produced and the electrical energy used.

The total charge and theoretical electron amount are

$$Q = (1.50 \times 10^4 \text{ A})(8.00 \text{ h} \cdot 3600 \text{ s/h}) = 4.32 \times 10^8 \text{ C}$$

$$n(e^-)_{total} = 4.32 \times 10^8/96\,485 = 4.48 \times 10^3 \text{ mol } e^-$$

Applying the 95.0% efficiency gives

$$n(e^-)_{useful} = 0.950(4.48 \times 10^3) = 4.25 \times 10^3 \text{ mol } e^-$$

Three electrons produce one aluminum atom.

$$n(Al) = 4.25 \times 10^3/3 = 1.42 \times 10^3 \text{ mol}$$

$$m(Al) = (1.42 \times 10^3 \text{ mol})(26.98 \text{ g/mol}) = 3.83 \times 10^4 \text{ g} = 38.3 \text{ kg}$$

Electrical energy in watt-hours is voltage multiplied by current and time in hours.

$$E = VIt = (4.50 \text{ V})(1.50 \times 10^4 \text{ A})(8.00 \text{ h}) = 5.40 \times 10^5 \text{ Wh} = 540 \text{ kWh}$$

Final answer: 38.3 kg of Al is produced, and 540 kWh of electrical energy is used.

Answer Key

Problem	Answer
8	2.48 L O_2
16	3.70 g Ni
32	84.0%
45	38.3 kg Al and 540 kWh

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