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CHEMISTRY WORKSHEET

FARADAY'S LAW

Course: SCH4U Grade 12 Chemistry

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50 Practice Problems with Answers and Detailed Solutions

FULL worksheet contains 50 representative problems on:

✓ Charge, current and time using Q = I·t, ✓ moles of electrons and Faraday's constant, ✓electroplating mass, ✓ time and current calculations, ✓ gas production during electrolysis, ✓current efficiency and percent yield of electrolysis, ✓ linked electrolytic cells in series, ✓ coating thickness.

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 (Problems 1-15)

Problem 8. In molten NaCl, chlorine gas forms according to the half-reaction below

$$2Cl^- \rightarrow Cl_2(g) + 2e^-$$

How many moles of $Cl_2(_g)$ form when 0.250 mol e^- are transferred?

Part B - Intermediate Problems (Problems 16-30)

Problem 16. Nickel is plated from $Ni^{2+}(_{aq})$ with a current of 5.00 A for 30.0 min. If the current efficiency is 80.0%, calculate the actual mass of $Ni(_s)$ deposited

Part C - Advanced Problems (Problems 31-40)

Problem 32. A gold layer 5.00 μm thick is plated on a 25.0 cm^2 surface from $Au^{3+}(_{aq})$. Gold has a density of 19.3 g/cm^3. Calculate the time required using 0.750 A at 85.0% efficiency

Part D - Challenge Problems (Problems 41-50)

Problem 45. Iodine is generated coulometrically by oxidizing iodide: $2I^- \rightarrow I_2 + 2e^-$. A 0.150 A current runs for 12.0 min and the I_2 produced reacts 1:1 with ascorbic acid in a 25.0 mL sample. Calculate the ascorbic acid concentration

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Section 3 - Solutions

Problem 8 Solution

Given: n_e = 0.250 mol e^- and 2 mol e^- form 1 mol Cl_2

Find: The moles of chlorine gas produced

The oxidation half-reaction shows that two moles of electrons are released for every mole of chlorine gas formed. The electron amount must therefore be divided by two.

Use the half-reaction mole ratio

$n_{Cl2} = n_e/2$

n_{Cl2} = 0.250 mol e^- ÷ 2 = 0.125 mol Cl_2

Final answer: n_{Cl2} = 0.125 mol

The answer is rounded to 3 significant figures

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Problem 16 Solution

Given: I = 5.00 A, t = 30.0 min, efficiency = 80.0%, M_{Ni} = 58.69 g/mol, and n = 2

Find: The actual mass of nickel deposited

Current efficiency describes the fraction of the supplied charge that actually plates nickel. The theoretical deposit is calculated from the total charge and then multiplied by 0.800.

Calculate the theoretical mass, then multiply by the efficiency as a decimal

$m_{actual} = m_{theoretical} \times \text{efficiency}$

$Q = 5.00\ A \times 1800\ s = 9000\ C$

$n_e = 9000\ C \div 96485\ C/mol\ e^- = 0.0933\ mol\ e^-$

$n_{Ni} = 0.0933 \div 2 = 0.0466\ mol$

$m_{theoretical} = 0.0466\ mol \times 58.69\ g/mol = 2.74\ g$

$m_{actual} = 2.74\ g \times 0.800 = 2.19\ g$

Final answer: $m_{Ni} = 2.19\ g$

The answer is rounded to 3 significant figures

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Problem 32 Solution

Given: Thickness = 5.00 μm, area = 25.0 cm^2, density = 19.3 g/cm^3, I = 0.750 A, efficiency = 85.0%, M_{Au} = 196.97 g/mol, and n = 3

Find: The plating time

The required gold mass is obtained from the coating volume and density. Because only 85.0% of the supplied charge deposits gold, the ideal charge is increased by dividing by the efficiency.

Find the gold mass from thickness and density, then use Faraday's law with efficiency correction

$Q_{supplied}$ = nF(m/M)/efficiency

5.00 μm = 5.00×10^{-4} cm

V = 25.0 cm^2 × 5.00×10^{-4} cm = 0.0125 cm^3

m = 19.3 g/cm^3 × 0.0125 cm^3 = 0.241 g

n_{Au} = 0.241 g ÷ 196.97 g/mol = 0.00123 mol

$Q_{theoretical}$ = 3 × 0.00123 × 96485 C = 355 C

$Q_{supplied}$ = 355 C ÷ 0.850 = 417 C

t = 417 C ÷ 0.750 A = 556 s = 9.27 min

Final answer: t = 9.27 min

The answer is rounded to 3 significant figures

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Problem 45 Solution

Given: $I = 0.150$ A, $t = 12.0$ min, 2 mol e^- form 1 mol I_2, I_2 reacts 1:1 with ascorbic acid, and sample volume = 0.0250 L

Find: The molar concentration of ascorbic acid

The current generates iodine in a precisely known amount, which is why this is a coulometric analysis. The 1:1 reaction with ascorbic acid transfers the iodine amount directly to the analyte amount.

Use current and time to find mol I_2, then use the 1:1 reaction stoichiometry

$C = n/V$

$Q = 0.150\ \text{A} \times 720\ \text{s} = 108\ \text{C}$

$n_e = 108\ \text{C} \div 96485\ \text{C/mol}\ e^- = 0.00112\ \text{mol}\ e^-$

$n_{I2} = 0.00112 \div 2 = 0.000560\ \text{mol}$

$n_{\text{ascorbic acid}} = 0.000560\ \text{mol}$

$C = 0.000560\ \text{mol} \div 0.0250\ \text{L} = 0.0224\ \text{M}$

Final answer: [ascorbic acid] = 0.0224 M

The answer is rounded to 3 significant figures

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Section 4 - Answer Key

Problem	Answer
8	0.125 mol Cl_2
16	2.19 g Ni
32	9.27 min
45	0.0224 M

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