

9.11 Electrolysis and Faraday's Law

Name: _____ Class: _____ Date: _____

Total: 13 marks

KEY WORDS charge 电荷 • electrolysis 电解 • faraday's law 法拉第定律

Objective

Build the skills to answer exam questions on **electrolysis and Faraday's law**.

You must be able to:

- convert **charge** 电荷 to **moles of electrons** with $F = 96\,500\text{ C/mol}$
- use $Q = It$ (current $\times$ time)
- find the mass or moles of product deposited

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ The electrolysis chain

Current deposits or releases substances at the electrodes. The route:

$$\text{charge } Q = It \rightarrow \text{mol } e^- = \frac{Q}{F} \rightarrow \text{mol product} \rightarrow \text{mass.}$$

 $F = 96\,500\text{ C/mol}$ is the charge on one mole of electrons.

■ A worked deposit

A current of 2.0 A for 965 s: $Q = It = (2.0)(965) = 1930\text{ C}$; $\text{mol } e^- = 1930/96\,500 = 0.020\text{ mol}$.

■ Electrons per ion

Use the half-reaction's electron count. $\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$ needs **2** electrons per Cu, so $\text{mol Cu} = (\text{mol } e^-)/2$.

■ Finish with mass

Mass = mol $\times$ molar mass. For 0.020 mol e^- depositing Cu: $\text{mol Cu} = 0.010$; mass = $0.010 \times 63.5 = 0.635\text{ g}$.

2 Practice

Now apply the methods above.

2.1 Write the equation for charge in terms of current and time. [1]

2.2 Find the charge from 3.0 A for 200 s. [2]

2.3 How many moles of electrons are in 9650 C? [2]

3 Exam-style questions

3.1 One mole of electrons carries a charge of about [1]

- A $6.02 \times 10^{23}\text{ C}$
- B 96 500 C
- C 1 C
- D 8.314 C

3.2 A current of 5.0 A flows for 1930 s through molten NaCl, depositing sodium ($\text{Na}^+ + e^- \rightarrow \text{Na}$).

(a) Find the total charge and the moles of electrons. [3]

(b) Find the mass of sodium deposited ($M = 23\text{ g/mol}$). [2]

3.3 A current deposits copper from Cu^{2+} . If 0.40 mol of electrons pass, find the moles of Cu deposited. [2]

Solutions

2.1 $Q = It$.

2.2 $Q = (3.0)(200) = 600 \text{ C}$.

2.3 $\frac{9650}{96\,500} = 0.10 \text{ mol}$.

3.1 B — 96 500 C (Faraday's constant).

3.2 (a) $Q = (5.0)(1930) = 9650 \text{ C}$; $\text{mol } e^- = 9650/96\,500 = 0.10 \text{ mol}$. (b) $\text{Na}^+ + e^- \rightarrow \text{Na}$ (1:1), so 0.10 mol Na; mass = $0.10 \times 23 = 2.3 \text{ g}$.

3.3 $\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$, so $\text{mol Cu} = 0.40/2 = 0.20 \text{ mol}$.