Exercise walk-through

Electrolysis and Faraday's Law ▪ 9.11

eXercise

You must be able to

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

Method — The electrolysis chain

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

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

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

Method — A worked deposit

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

Method — Electrons per ion

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

Method — Finish with mass

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

Practice 2.1 ▪ 1 mark

Write the equation for charge in terms of current and time.

Solution 2.1

Method: The electrolysis chain

Worked steps

$Q = It$ B1.

Practice 2.2 ▪ 2 marks

Find the charge from 3.0 A for 200 s.

Solution 2.2

Method: The electrolysis chain

Worked steps

$Q = (3.0)(200) = 600$ C M1 A1.

Practice 2.3 ▪ 2 marks

How many moles of electrons are in 9650 C?

Solution 2.3

Worked steps

$$\frac{9650}{96\,500} = 0.10 \text{ mol}$$ M1 A1.

Exam-style 3.1 ▪ 1 mark

One mole of electrons carries a charge of about

A 6.02×10^{23} C

B $96\,500$ C

C 1 C

D 8.314 C

Solution 3.1

Method: The electrolysis chain

A 6.02×10^{23} C

B $96\,500$ C ✓

C 1 C

D 8.314 C

Worked steps

B — $96\,500$ C (Faraday's constant).

Exam-style 3.2 ▪ 3 marks

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

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

(b) Find the mass of sodium deposited ($M = 23$ g/mol).

Solution 3.2

Method: The electrolysis chain

Worked steps

(a) $Q = (5.0)(1930) = 9650$ C; mol $e^- = 9650/96\,500 = 0.10$ mol M1 M1 A1.

(b) $Na^+ + e^- \to Na$ (1:1), so 0.10 mol Na; mass $= 0.10 \times 23 = 2.3$ g M1 A1.

Exam-style 3.3 ▪ 2 marks

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

Solution 3.3

Method: The electrolysis chain

Worked steps

$\mathrm{Cu}^{2+} + 2e^- \rightarrow \mathrm{Cu}$, so mol Cu $= 0.40/2 = 0.20$ mol M1 A1.