Exercise walk-through

Electrolysis ▪ 24.1

eXercise

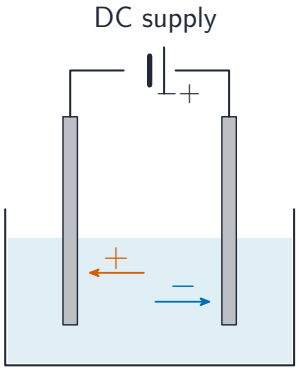
You must be able to

- predict the products of electrolysis (molten or aqueous, from the redox series)
- use $F = Le$ and $Q = It$
- calculate the mass or volume of substance liberated

Method — Electrolysis and its products

A **molten** electrolyte gives the metal (cathode) and non-metal (anode). An **aqueous** one: a reactive metal gives H instead at the cathode; the anode gives O unless a concentrated halide gives the halogen.

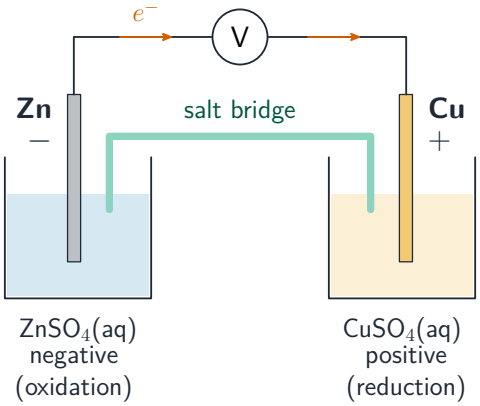
Method — Electrolysis and its products



cathode $(-)$ **anode** $(+)$

reduction oxidation

Method — Electrolysis and its products



Electrolysis is the reverse of an electrochemical cell

Method — Calculations

$F = Le$ (Faraday = Avogadro × electron charge). $Q = It$, then: moles of e = Q/F → moles of product (from the half-equation) → mass or volume.

Example. 2.0 A for 30 min through CuSO ($Cu^{2+} + 2e^- \rightarrow Cu$):

$Q = 2.0 \times 1800 = 3600$ C; mol e = $3600/96500 = 0.0373$; mol Cu = 0.0187;

$m = 0.0187 \times 64 = 1.2$ g.

Practice 2.1 ▪ 2 marks

State what is formed at the cathode and anode when **molten** sodium chloride is electrolysed.

Solution 2.1

Method: Electrolysis and its products

Worked steps

cathode: sodium (metal); anode: chlorine B1 *each*.

Practice 2.2 ▪ 1 mark

Write the relationship between the Faraday constant, the Avogadro constant and the electron charge.

Solution 2.2

Method: Calculations

Worked steps

$F = Le$ (B1).

Exam-style 3.1 ▪ 1 mark

At the cathode during electrolysis, positive ions are:

A oxidised (lose electrons)

B reduced (gain electrons)

C neutralised

D unchanged

Solution 3.1

Method: Electrolysis and its products

A oxidised (lose electrons)

B reduced (gain electrons) ✓

C neutralised

D unchanged

Worked steps

B. Cations are reduced at the cathode.

Exam-style 3.2 ▪ 1 mark

What charge passes when a current of 1.5 A flows for 200 s?

A 130 C

B 300 C

C 0.0075 C

D 3.0 C

Solution 3.2

A 130 C

B 300 C ✓

C 0.0075 C

D 3.0 C

Worked steps

B. $Q = It = 1.5 \times 200 = 300$ C.

Exam-style 3.3 ▪ 1 mark

A current of 0.50 A flows for 1 hour through silver nitrate solution: $Ag^+ + e^- \rightarrow Ag$. ($F = 96\,500$ C mol^{-1}, A_r Ag $= 108$.)

(a) Calculate the charge passed.

(b) Calculate the mass of silver deposited at the cathode.

Solution 3.3

Method: Calculations

Worked steps

(a) $Q = It = 0.50 \times 3600 = 1800$ C **B1**.

(b) mol e $= 1800/96500 = 0.01865$ **M1**; $Ag^+ + e^- \rightarrow$ Ag so mol Ag $= 0.01865$ **M1**; $m = 0.01865 \times 108 = 2.0$ g **A1**.

Exam-style 3.4 ▪ 2 marks

Explain why electrolysing **aqueous** sodium chloride gives hydrogen at the cathode, not sodium.

Solution 3.4

Method: Electrolysis and its products

Worked steps

sodium is too reactive (very negative electrode potential) M1, so the water/H is reduced instead, releasing hydrogen A1.