

24.1 Electrolysis

Name: _____ Class: _____ Date: _____

Total: 11 marks

KEY WORDS electrolysis 电解 • faraday constant 法拉第常量 • avogadro constant 阿伏伽德罗常量
• electrolyte 电解质 • cathode 阴极

Objective

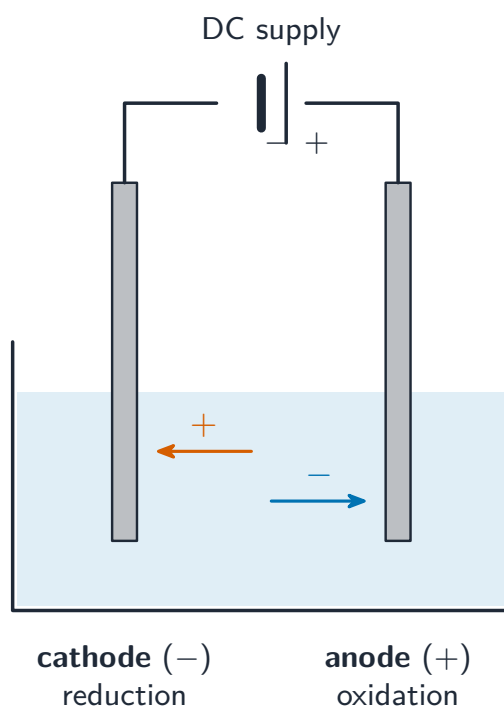
Build the skills to answer exam questions on **electrolysis** 电解 — predicting the products, the **Faraday constant** 法拉第常量, and electrolysis calculations.

You must be able to:

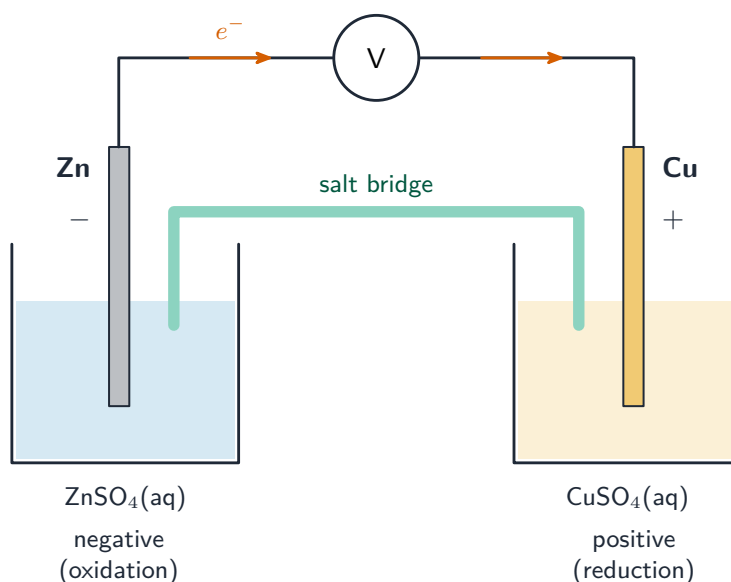
- predict the products of electrolysis (molten or aqueous, from the redox series)
- use $F = Le$ and $Q = It$
- calculate the mass or volume of substance liberated

1 Worked examples

- Electrolysis and its products



Cathode (-): positive ions gain electrons (reduction). Anode (+): negative ions lose electrons (oxidation)



Electrolysis is the reverse of an electrochemical cell

A **molten** electrolyte gives the metal (cathode) and non-metal (anode). An **aqueous** one: a reactive metal gives H₂ instead at the cathode; the anode gives O₂ unless a concentrated halide gives the halogen.

■ Calculations

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

Example. 2.0 A for 30 min through CuSO_4 ($\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$): $Q = 2.0 \times 1800 = 3600$ C; mol $e^- = 3600/96500 = 0.0373$; mol Cu = 0.0187; $m = 0.0187 \times 64 = 1.2$ g.

2 Practice

2.1 State what is formed at the cathode and anode when **molten** sodium chloride is electrolysed. [2]

2.2 Write the relationship between the Faraday constant, the Avogadro constant and the electron charge. [1]

3 Exam-style questions

3.1 At the cathode during electrolysis, positive ions are: [1]

- A oxidised (lose electrons)
 - B reduced (gain electrons)
 - C neutralised
 - D unchanged
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3.2 What charge passes when a current of 1.5 A flows for 200 s? [1]

- A 130 C
 - B 300 C
 - C 0.0075 C
 - D 3.0 C
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3.3 A current of 0.50 A flows for 1 hour through silver nitrate solution: $\text{Ag}^+ + e^- \rightarrow \text{Ag}$. ($F = 96\,500$ C mol $^{-1}$, A_r Ag = 108.)

(a) Calculate the charge passed. [1]

(b) Calculate the mass of silver deposited at the cathode. [3]

3.4 Explain why electrolysis of **aqueous** sodium chloride gives hydrogen at the cathode, not sodium. [2]

Solutions

2.1 cathode: sodium (metal); anode: chlorine.

2.2 $F = Le$.

3.1 B. Cations are reduced at the cathode.

3.2 B. $Q = It = 1.5 \times 200 = 300 \text{ C}$.

3.3 (a) $Q = It = 0.50 \times 3600 = 1800 \text{ C}$.

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

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