

Exercise walk-through

4.1

Electrolysis

IGCSE Chemistry

What electrolysis is, and what it needs

Electrolysis splits an ionic compound by passing a current through it.

- it works only when the substance is **molten or dissolved**, because only then are the **ions** free to move and carry the charge
- a **solid** ionic compound cannot be electrolysed at all – its ions are locked in place

That single fact answers a whole family of questions: "why does solid lead bromide not conduct?"

The electrolytic cell

Two electrodes in an **electrolyte** . The **cathode** is negative (cations go there and gain electrons – reduction). The **anode** is positive (anions lose electrons – oxidation).

Products at each electrode

cathode (−) $\longrightarrow$ metal or hydrogen

anode (+) $\longrightarrow$ non-metal

Cathode: metals & **hydrogen** .

Anode: **non-metals** .

molten PbBr_2 : lead | bromine

conc. $\text{NaCl}(\text{aq})$: hydrogen |
chlorine

dilute H_2SO_4 : hydrogen | oxy-
gen

What is formed at each electrode

the simple rule

metals and hydrogen go to the cathode; non-metals go to the anode

molten compounds

only two ions are present, so the products are always the metal and the non-metal

concentrated

NaCl solution

hydrogen at the cathode, chlorine at the anode

dilute

sulfuric acid

hydrogen at the cathode, oxygen at the anode

copper electrodes

sulfate with copper

copper deposits at the cathode and dissolves from the anode – purification

why it varies

in solution, water can be decomposed too, so what wins depends on concentration and on the ions present

The **electric current** is carried by **ions moving** in the electrolyte and by **electrons** in the wires – never by electrons through the liquid.

How the charge moves

- **Electrons** move through the wires (the **external circuit**) from the power supply.
- At the cathode, positive ions gain electrons. Gaining electrons is **reduction**.
- At the anode, negative ions lose electrons. Losing electrons is **oxidation**.
- Inside the electrolyte, the ions move: positive ions go to the cathode and negative ions go to the anode.

Exercises 2.1·2.2

2.1 State why solid sodium chloride cannot be electrolysed. [1]

2.2 Name the products at each electrode when molten lead(II) bromide is electrolysed. [2]

Exercises 2.1·2.2

2.1 State why solid sodium chloride cannot be electrolysed. [1]

2.1

- in the solid the ions are **locked in place** and cannot move to carry the charge
-

2.2 Name the products at each electrode when molten lead(II) bromide is electrolysed. [2]

2.2

- cathode (negative): **lead**
- anode (positive): **bromine**

Exercise 3.1

3.1 At the cathode during electrolysis, positive ions:

[1]

☐

A lose electrons (oxidation)

B gain electrons (reduction)

C stay unchanged

D become anions

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3.1 B

- at the cathode, positive ions **gain electrons (reduction)**
- A is oxidation at the anode; C and D are wrong

Exercise 3.2 (a)

3.2 Dilute sulfuric acid is electrolysed using inert carbon electrodes.

(a) Name the gas formed at each electrode, and state the ratio of their volumes. [3]

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(a)

- anode: **oxygen**
- cathode: **hydrogen**
- volume ratio $\text{H}_2 : \text{O}_2 = \mathbf{2 : 1}$

Exercise 3.2 (b)

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(b)

- $2\text{H}^+ + 2e^- \rightarrow \text{H}_2$
- H^+ is lower than sulfate in the discharge order, so sulfate **stays in solution**

Exercise 3.3

3.3 Describe how you would electroplate an iron spoon with silver.

[3]

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[3]

3.3

- make the spoon the **cathode**
- make **silver** the anode
- use a solution containing **silver ions** as the electrolyte