The process of electrolysis

4.4.3.1 · Chemical changes · revision notes

What electrolysis is, why an ionic compound must be molten or dissolved to be electrolysed, and which way the ions move. This is the basis of every other electrolysis subtopic and often opens a longer question.

Key facts

- Electrolyte = molten or dissolved ionic compound; its ions are free to move
- Positive ions → cathode; negative ions → anode
- Discharged = an ion gains or loses electrons to become an element
- Cathode = negative electrode; anode = positive electrode
- PANIC: Positive is Anode, Negative Is Cathode
- Inert electrodes (graphite, platinum) do not react

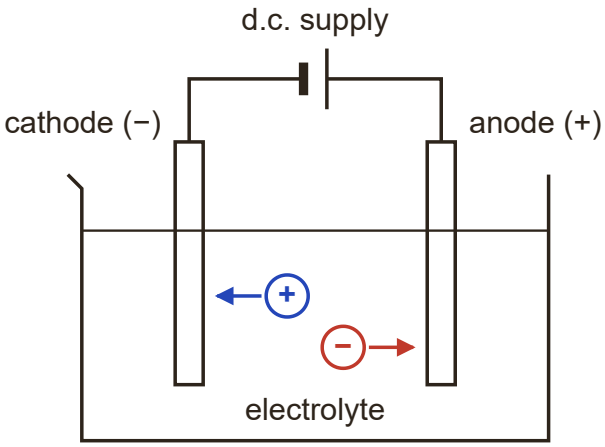
Notes

Electrolytes

- Ionic compounds conduct electricity when **melted** (molten) or **dissolved in water**, because the ions are then **free to move**.
- Solid ionic compounds do not conduct: the ions are held in fixed positions in the lattice and cannot move.
- A molten or dissolved ionic compound that conducts electricity is called an **electrolyte**.
- **Electrolysis** is breaking down an electrolyte into elements using electricity (a direct current).

Movement of ions

- Two **electrodes** dip into the electrolyte and are connected to a d.c. power supply.
- The **cathode** is the **negative** electrode. **Positive** ions, such as metal ions and H^+, are attracted to it.
- The **anode** is the **positive** electrode. **Negative** ions, such as Cl^-, Br^- and O^{2-}, are attracted to it.
- Opposite charges attract, so each ion moves towards the electrode with the opposite charge.
- Coloured ions show this movement: in copper chromate solution, blue Cu^{2+} ions move to the cathode and yellow CrO_4^{2-} ions move to the anode.



positive ions → cathode; negative ions → anode

Opposite charges attract. The short thick line of the cell symbol is the negative terminal.

Discharge at the electrodes

- At the electrodes the ions are **discharged**: they gain or lose electrons and form elements.
- At the cathode, positive ions gain electrons, so a metal (or hydrogen) is produced.
- At the anode, negative ions lose electrons, so a non-metal such as a halogen or oxygen is produced.
- **Inert electrodes**, e.g. graphite or platinum, are used so that the electrodes do not react with the electrolyte or the products.

How to answer each type of question

Define key terms 1 mark each **Grade 4**

1. Learn short, exact definitions of electrolyte, electrolysis, cathode and anode.
2. Include the charge when you name an electrode.

Example. (a) What is an electrolyte?
(b) What is the name of the positive electrode?

Model answer.

(a) A molten or dissolved ionic compound / a liquid or solution that conducts electricity (1)
(b) Anode (1)

Predict which electrode ions move to, and why 2 marks **Grade 5**

1. Positive ions go to the cathode (negative); negative ions go to the anode (positive).
2. Explain using attraction between opposite charges.

Example. Molten zinc chloride, $ZnCl_2$, is electrolysed.
(a) Which ions move to the cathode?
(b) Explain why.

Model answer.

(a) Zinc ions / Zn^{2+} (1)
(b) They are positive, so they are attracted to the negative electrode (1)

Explain why an ionic compound conducts only when molten or dissolved 2 to 3 marks **Grade 4**

1. Say what the ions do in the solid: fixed in position in a lattice, cannot move.
2. Say what changes when it melts or dissolves: the ions are free to move.
3. Link moving ions to carrying charge through the liquid.

Example. Solid sodium chloride does not conduct electricity, but molten sodium chloride does. Explain why.

Model answer.

In the solid, the ions are held in fixed positions (in a lattice), so they cannot move (1)
When molten, the ions are free to move (1)
so they can carry charge / current through the liquid (1)

Don’t lose marks

- Saying electrons move through the electrolyte: in the electrolyte it is the ions that move.
- Mixing up which electrode is positive and which is negative.
- Saying solid ionic compounds do not conduct because they have no ions: they have ions, but the ions cannot move.
- Writing 'molecules' or 'atoms' when you mean ions.

More tips

Memory tricks

- PANIC: Positive Anode, Negative Is Cathode.
- Cations go to the cathode and anions go to the anode (match the first letters: cat–cat, an–an).
- Opposites attract: positive ions to the negative electrode, negative ions to the positive electrode.

Exam technique

- In conduction questions, the phrase 'ions are free to move' earns the key mark.
- Name an electrode and give its charge: 'the cathode (negative electrode)'.
- If you draw the apparatus, label the d.c. supply, both electrodes (cathode and anode) and the electrolyte.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Name the electrodes and their charges**
The cathode is the negative electrode and the anode is the positive electrode.

Grade 4 — **Define an electrolyte**
A molten or dissolved ionic compound, which conducts electricity because its ions are free to move.

Grade 4 — **Explain why solid ionic compounds do not conduct**
In a solid the ions are held in fixed positions in a lattice, so they cannot move to carry charge.

Grade 5 — **Predict which electrode each ion moves to**
Positive ions move to the cathode and negative ions move to the anode.

Grade 5 — **Explain what happens when ions are discharged**
At the electrodes, ions gain or lose electrons and become atoms or molecules of elements.

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