



# AQA GCSE Chemistry

## Topic 4: Chemical changes

### Electrolysis

#### Notes

(Content in bold is for Higher Tier only)



## The process of electrolysis

- When an ionic substance is melted or dissolved, the ions are free to move about within the liquid or solution.
- Passing a current through substances that are molten or solution means that the solution can be broken down into elements. This is electrolysis, and the substance being broken down is the electrolyte.
- During electrolysis, **positively charged ions** move to the **negative electrode** (cathode), and **negatively charged ions** move to the **positive electrode** (anode).
- Ions are discharged at the electrodes producing elements

## Electrolysis of molten ionic compounds

- When a simple ionic compound (e.g lead bromide) is electrolysed in the molten state using inert electrodes, the metal (lead) is produced at the cathode and the non-metal (bromine) is produced at the anode
- this is because the metal is the positive ions and the non-metal is the negative ions

## Using electrolysis to extract metals

- Metals that are more reactive than carbon (e.g aluminium), so too reactive to be extracted by reduction with carbon, are extracted by electrolysis of molten compounds.
- Large amounts of energy are used in the extraction process to melt the compounds and to produce the electrical current.
- Aluminium is manufactured by the electrolysis of a molten mixture of aluminium oxide and cryolite using carbon as the positive electrode (anode).
  - Aluminium oxide has a very high melting point, so it would be too expensive to melt it, which is why it is mixed with cryolite
  - the positive electrodes need to be continually replaced because oxygen is formed, which reacts with the carbon of the positive electrodes, forming carbon dioxide, and they gradually burn away
- Metals that react with carbon can be extracted by electrolysis as well

## Electrolysis of aqueous solutions

- The ions discharged when an aqueous solution is electrolysed using inert electrodes depend on the relative reactivity of the elements involved.
- At the negative electrode (cathode), hydrogen is produced unless the metal is less reactive than hydrogen. This is because more reactive ions want to stay within the solution.
- At the positive electrode, if OH<sup>-</sup> and halide ions (Cl<sup>-</sup>, Br<sup>-</sup>, I<sup>-</sup>) are present, then one of the halide ions will be produced. If no halide is present, oxygen is formed.
- This happens because in the aqueous solution water molecules break down producing H<sup>+</sup> ions and OH<sup>-</sup> ions that are discharged



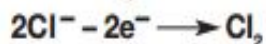


### Representation of reactions at electrodes as half equations

- This is an example of a half equation; the small number is always the same as the 2 larger numbers within the equation. & electrons are represented by the symbol 'e<sup>-</sup>'



or



- writing half equations for the reactions at each electrode:
  - negative electrode:  $\text{X}^+ \rightarrow \text{X}$ , so ionic equation must be:  $\text{X}^+ + \text{e}^- \rightarrow \text{X}$ , electrons gained, so positive ions are reduced
  - positive electrode:  $\text{X}^- \rightarrow \text{X}$ , so ionic equation must be:  $\text{X}^- \rightarrow \text{e}^- + \text{X}$ , electrons are lost, so negative ions are oxidised

