Chemistry Knowledge Organiser
C6 - Electrolysis

Extracting Aluminium

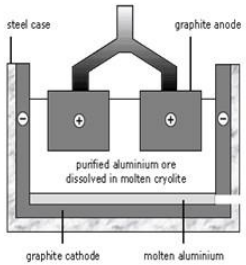
Aluminium oxide is dissolved in molten cryolite .
Cryolite reduces the melting point of aluminium oxide meaning the process requires less energy.
Aluminium ions (Al+) are attracted to the negative electrode.
Aluminium atoms are formed at the negative electrode (gain 1 electron)
Oxide ions are attracted to the positive electrode
Oxygen is formed at the positive electrode (each ion loses 2 electrons)
Oxygen reacts with carbon to make carbon dioxide. This electrode needs to be replaced constantly.

At the negative electrode:

$Al^{3+} + 3e- \longrightarrow Al$

At the positive electrode

$2O_{2-} \longrightarrow O_2 + 4e-$



Overall equation:

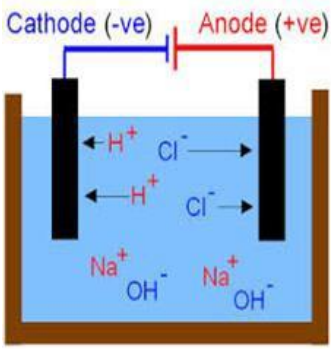
$2Al_2O_3 \rightarrow 4Al+3O_2$

Electrolysis of Brine

Which elements form at which electrode depends on the **reactivity** of the elements involved.
For example, the electrolysis of brine, is the electrolysis of a solution of sodium chloride, however there are also H^+ and OH^- ions form the water which is used as the solvent. This means there is more than one possible ion that can go to each electrode.

· **Positive ions:** sodium (Na^+) and hydrogen (H^+)
· **Negative ions:** chlorine (Cl^-) and hydroxide (OH^-)

When there is a mixture of ions, the products formed depend on the reactivity of the elements involved.
Hydrogen is less reactive than sodium, so hydrogen gas (H_2) is produced at the negative electrode.
Chlorine gas (Cl_2) is produced at the positive electrode.
Sodium hydroxide is produced from the ions that remain in solution.



Gas Tests

During electrolysis the products made are often gases. Below are the tests for three common gases you need to know:

Gas	Test	Result
Hydrogen	Place a lit splint into the gas	If a squeaky pop is heard hydrogen is present
Oxygen	Place glowing splint into gas	If splint is relighted then oxygen is present
Chlorine	Damp litmus paper placed in gas	If paper bleaches, chlorine is present
Carbon Dioxide	Bubble the gas through limewater	If the limewater goes cloudy carbon dioxide is present

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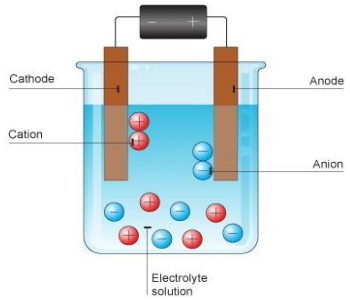
Electrolysis

When an ionic compound is melted or dissolved in water, the ions **are free to** move about within the liquid or solution. These liquids and solutions are able to conduct electricity and are called **electrolytes.**

If an electric current is passed through this solution the ions will move to the electrodes. **Remember-opposites attract**. **The positive ions (cations) will go to the negative electrode (cathode), the negative ions (anions) go to the positive electrode (anode).**
For example in the electrolysis of lead bromide, Lead (Pb^{2+}) goes to the negative electrode and bromine (Br^{-1}) goes to the positive electrode.



Electrolysis of Copper Sulphate

Which elements form at which electrode depends on the **reactivity** of the elements involved. For example, in the electrolysis of aqueous copper sulphate is the electrolysis of copper sulphate, however there are also H^+ and OH^- ions form the water which is used as the solvent. This means there is more than one possible ion that can go to each electrode.
· **Positive ions:** sodium (Cu^{2+}) and hydrogen (H^+)
· **Negative ions:** sulphate(SO_4^{2-}) and hydroxide (OH^-)
When there is a mixture of ions, the products formed depend on the reactivity of the ions involved.
Copper is **less reactive** than hydrogen, so copper (Cu) is produced at the negative electrode.
The half equation is:
$Cu^{2+} + 2e^- \rightarrow Cu$
The hydroxide ion is more reactive than the sulphate ion, therefore this **forms water (H_2O) and oxygen** at the positive electrode.
$4OH^- \rightarrow O_2 + 2H_2O + 4\,2e^-$

As a rule if a halide ion is present , this will form at the positive electrode, however if no halide is present then oxygen and water will form at the positive electrode.

Key Terms	Definitions
Electrolysis	The breaking down of a substance using electricity
Electrolyte	The solution which is being broken down during electrolysis
Oxidation	The loss of electrons
Reduction	The gain of electrons
Anode	The positive electrode
Cathode	The negative electrode
Half Equation	An equation that shows the reaction at each electrode

Oxidation and reduction

When a positive Ion reaches the negative electrode, it gains electrons. This is a reduction reaction.
When the negative ion reaches the positive electrode, it loses electrons, this is an oxidation reaction.
We can represent these using half equations A half equation can represent the reaction at each electrode. Half equations show how electrons are transferred and an electron is represented in an equation by an e^- symbol
Half equations show electrons (e^-) and how ions become atoms.
For example $Cu^{2+} + 2\,e^- \rightarrow Cu$.
1. Write down the ion and atom: $Cl^- \rightarrow Cl_2$
2. Adjust the number of ions (if needed) and add electrons to balance the charges if required $2Cl^- \rightarrow Cl_2 + 2\,e^-$

Remember that non metal ions will typically form diatomic molecules.

Ionic equations

Half equations can be combined to form an ionic equation, which shows the overall reaction.
For example in the electrolysis of copper chloride the two half equations are:

At the negative electrode (cathode):
$Cu^{2+} + 2\,e^- \rightarrow Cu$
At the positive electrode (anode):
$2Cl^- \rightarrow Cl_2 + 2\,e^-$
Combing these 2 equations gives us:

$Cu^{2+} + 2\,e^- + 2Cl^- \rightarrow Cu + Cl_2 + 2\,e^-$ The electrons either side of the equation cancel out, meaning the final ionic equation is:
$Cu^{2+} + 2Cl^- \rightarrow Cu + Cl_2$
In an ionic equation it is important to check both the atoms and the charges balance