Definitions

Electrolysis → The use of electricity to break down or decompose a compound (usually an ionic compound in molten or aqueous state).
Electrolysis takes place in an **electrolytic cell** made of batteries, electrodes (an anode and a cathode) and an electrolyte.
Anode → attracts anions
Cathode → attracts cations
Electrolyte → The compound to be electrolysed.

Main Concepts

The electrolyte is the compound that will be broken down.
Cations are attracted to the cathode, where they gain electrons.
Anions are attracted to the anode, where they lose electrons.
The process of losing a charge (whether it's positive or negative) is called **discharge**.
The transfer of electrons from the cathode to the cation / anion to the anode discharges the ions, hence they do not recombine as they are now neutral.

Ease of Ion Discharge

Hardest to Discharge	Hardest to Discharge
K^+	$SO4^{2-}$
Na^+	$NO3^-$
Ca^{2+}	F^-
Mg^{2+}	Cl^-
Zn^{2+}	Br^-
Fe^{2+}	I^-
Pb^{2+}	OH^-
H^+	
Cu^{2+}	
Ag^+	
Easiest to Discharge	Easiest to Discharge

$SO4^{2-}$ and $NO3^-$ are not discharged and remain in solutions

Electrolysis - Change in Electrolyte (NaCl)

1) Molten NaCl
Ions Present - Na^+, Cl^-
At anode: $2Cl^-$ (l) → Cl2 (g) + $2e^-$
At cathode: Na^+ (l) + e^- → Na (l)
Cathode: Silvery globules of sodium
Anode: Yellowish-green chlorine gas evolved
2) Dilute NaCl Solution
Ions Present: H^+, Na^+, OH^-, Cl^-
At anode: $4OH^-$ (aq) → 2H2O (l) + O2 + $4e^-$
At cathode: $2H^+$ (aq) + $2e^-$ → H2 (g)
Cathode: Hydrogen gas released
Anode: Oxygen gas is released
3) Concentrated NaCl Solution
Ions present: H^+, Na^+, OH^-, Cl^-
At anode: $2Cl^-$ (aq) → Cl2 (g) + $2e^-$
At cathode: $2H^+$ (aq) + $2e^-$ → H2 (g)
Cathode: Hydrogen gas released
Anode: Yellowish-green chlorine gas released

For solutions with more than 1 cation/anion, selective discharge will take place.

If you forget the polarity of the electrodes, don't **PANIC**.
Positive is **A**node, **N**egative **I**s **C**athode.

Selective Discharge

At the cathode, cation discharge is **ONLY** affected by the metal reactivity series. The less reactive the metal, the easier it is to discharge, hence it will be discharged in preference to more reactive metals.
Inert Cathodes: Cations will be discharged
Reactive Cathodes: If anode is made of the same metal, a layer of metal coating will form on the cathode.
At the anode, anion discharge is affected by the concentration of the ion. Halogen ions (Cl^- / Br^- / I^-) are discharged in preference to OH^- ions in concentrated solutions.
Sulfate ions and nitrate ions are **NOT** discharged and will remain in solutions.

Selective Discharge (cont)

Inert Anodes: Anions will be discharged
Reactive Anodes: Will dissolve and oxidise to form cations

Simple Cell

Simple cells convert chemical potential energy into electrical energy. Electrolysis requires energy to occur while simple cells generate energy (spontaneous reaction).
Chemical Potential Energy → Electrical Energy
For simple cells, the anode is negative while the cathode is positive. The electrodes are made of different reactive metals at different positions in the metal reactivity series. The pair of metals with the greatest p.d. is the pair that is the furthest apart in the metal reactivity series.
The more reactive metal (higher in electrochemical series) will become the negative terminal. The atom of the reactive metal will lose electron(s) to form positive ions and dissolve into the solution. Oxidation takes place.
The electrons lost by the more reactive metal are then moved to the other metal plate through the wire. As a result, current is produced (there is a potential difference) and the ammeter / voltmeter deflects.
The less reactive metal (lower in electrochemical series) will become the positive terminal. At the positive terminal, the positive ions in the solution (electrolyte) will gain electrons (from the negative terminal) and be discharged.
If the positive ions are less reactive than hydrogen, a metal coating will be formed at the positive terminal.
If the positive ions are more reactive than hydrogen, effervescence (hydrogen gas) is formed at the positive terminal.

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Uses of Electrolysis

1) Electrolytic Purification

Metals can be purified by using an electrolytic process. To purify the metal, a piece of pure metal (e.g. copper) is placed as the negative cathode, and the impure metal is placed as the positive anode. When the electrical circuit is closed, only the pure metal would dissolve from the anode (impure metal) to form metal ions, which are attracted to the cathode where they are deposited as the pure metal.

2) Electroplating

Electroplating is the process of depositing a layer of metal on another substance using electrolysis. Uses of electroplating include decorative finish, as well as to prevent rusting. The electrolyte used contains the cation of the metal to be plated. The anode is the metal to be used as coating, and the cathode is the object to be plated.

3) Batteries

Batteries can be made from simple cells. A simple cell is a device that converts chemical energy into electrical energy. It is also known as an electric cell. It is made by placing two different metals in contact with an electrolyte. The metals act as electrodes for the simple cell.

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