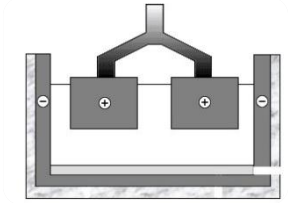
90311 Describe oxidation-reduction reactions – Electrolysis revision

Used for the extraction of elements from their ores

eg Aluminium metal from molten alumina, aluminium oxide Al_2O_3

- Cryolite added to lower m.pt. & so save $$$
- RED: $Al^{3+} + 3e^- \rightarrow Al$ (x4)
- OX: $2O^{2-} \rightarrow O_2 + 4e^-$ (x3)
- $4Al^{3+} + 6O^{2-} \rightarrow 4Al + 3O_2$
- The hot C anodes burn in the O_2 producing CO_2 & need replacing from time to time



Electrolysis of molten ionic compounds eg NaCl(l) or $PbBr_2$

- RED: $Na^+ + e^- \rightarrow Na$ (x2)
- Ox: $2Cl^- \rightarrow Cl_2 + 2e^-$
- $2Na^+ + 2Cl^- \rightarrow Na + Cl_2$

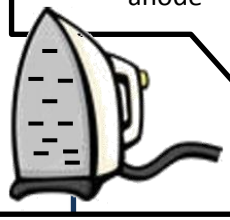
- RED: $Pb^{2+} + 2e^- \rightarrow Pb$
- Ox: $2Br^- \rightarrow Br_2 + 2e^-$
- $Pb^{2+} + 2Br^- \rightarrow Pb + Br_2$

The compound is broken down into its elements

ELECTROLYSIS

Anode (+)

Anions (-) ions are attracted to the anode



Cathode (-)

Cations (+) are attracted to the cathode

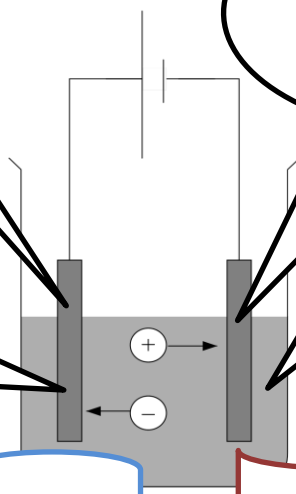
Electrodes

Redox reactions occur at these.

May be inert or may take part in the redox reaction.

Electrolyte

Liquid that contains ions that are free to move e.g. molten(l) or aqueous(aq) ionic substance



oxid**A**tion occurs at the **A**node: loss of electrons

redu**C**tion occurs at the **C**athode: gain of electrons

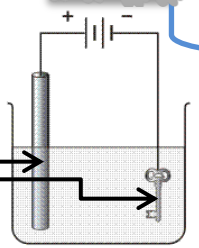
Electroplating

Uses electrical current to reduce cations of a desired material from a solution and coat a conductive object with a thin layer of metal. Eg Ag anode, $AgNO_3$ electrolyte & a metal key as cathode.

Anode: dissolves…. $Ag \rightarrow Ag^+ + e^-$

Cathode: plated… $Ag^+ + e^- \rightarrow Ag$

[Ag^+(aq) in electrolyte remains unchanged]



Electrolysis of water

Overall: $2H_2O \rightarrow 2H_2 + O_2$

- Red: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ (x2)
- Ox: $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$

Electrolysis of aqueous ionic compounds eg NaCl(aq)

$2H^+ + 2e^- \rightarrow H_2$ (hydrogen gas at the (-)cathode – reduction)

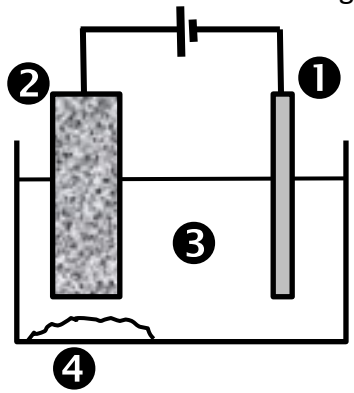
$2Cl^- \rightarrow Cl_2 + 2e^-$ (chlorine gas at the (+)anode - oxidation)

Na^+ ions & OH^- ions are left in solution, as NaOH(aq). *If the solution is concentrated Cl_2 is produced, but if it is dilute, OH^- breaks down into O_2 & H_2O

$2OH^- \rightarrow 2H^+ + O_2 + 4e^-$ OR written as $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$

PURIFICATION OF COPPER

- ❶ Pure (thin) copper cathode
- ❷ Impure "blister copper" anode
- ❸ Copper sulfate (or chloride) electrolyte, contains $Cu^{2+}(aq)$ – responsible for the blue colour of solution
- ❹ Copper anode dissolves as it is oxidised – the impurities fall in pile below anode as "anode sludge"
- Anode = oxidation: $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$
- Cathode = reduction: $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$; copper cathode increases in size as it becomes plate/coated with pure copper
- Overall equation $Cu(s) + Cu^{2+}(aq) \rightarrow Cu^{2+}(aq) + Cu(s)$
- The rate at which the copper ions enter the electrolyte from the anode is the same as the rate at which the copper ions leave the electrolyte at the cathode. The concentration of the $Cu^{2+}(aq)$ therefore remains virtually unchanged so the blue colour of solution remains unchanged.



- Sludge may contains valuable metals such as silver or gold and is recovered

MY EXTRA NOTES