Reactivity series of metals (from most reactive to least reactive)

Potassium (K)
Sodium (Na)
Calcium (Ca)
Magnesium (Mg)
Aluminium (Al)
Carbon (C)
Zinc (Zn)
Iron (Fe)
Tin (Sn)
Lead (Pb)
Hydrogen (H)
Cu (Copper)
Mercury (Hg)
Ag (Silver)
Au (Gold)
Pt (Platinum)

More reactive displaces less reactive
More -> Less

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- At the anode (Cl- and OH- are present)
  - **$2Cl^-$ (aq) -> Cl_2 (g) + $2e^-$**
  - **Cl- is discharged** instead of OH- as it is concentrated and chlorine gas is produced

Electrolysis of copper (II) sulfate solution using copper electrodes

- At the cathode (Cu+ and H+ are present)
  - Cu^{2+} (aq) + $2e^-$ -> Cu(s)
  - Copper metal is produced – reddish brown solid observed; at the same time, copper deposits are forming on cathode so it is increasing in size
- At the anode (SO_4^{2-} and OH- are present)
  - Cu(s) -> Cu^{2+} (aq) + $2e^-$
  - The anode is reacting to form copper ions, therefore the anode is decreasing in size

The amount of copper (II) ions remains the same overall as for every one copper (II) ion reduced in the cathode to make copper metal, a copper (II) ion is formed at the anode.

Industrial applications of electrolysis

Extraction of aluminum (or other reactive metals)

- Aluminium is usually extracted from bauxite ore (an impure aluminium oxide containing iron oxides, silicon dioxide, titanium dioxide, etc.) by electrolysis
- The ore is first converted into pure aluminium oxide (Al_2O_3), which is then dissolved in molten cryolite (Na_3AlF_6) to lower the melting point of the aluminium oxide such that electrolysis can be carried out.

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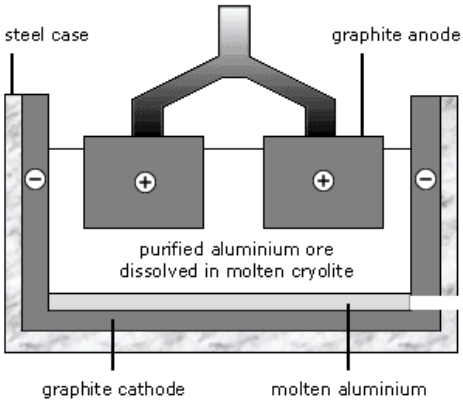
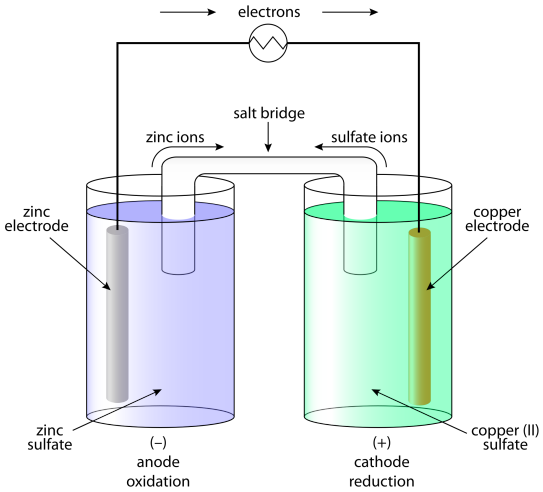
Equation at anode: $2O^{2-}$ (l) -> O_2(g) + $4e^-$
Equation at cathode: Al^{3+} (l) + $3e^-$ -> Al(l)
Overall equation: $2Al_2O_3$ (l) -> $3O_2$ (g) + 4Al(l)



Purification of Copper

- **Impure** copper -> **anode**
- **Pure** copper -> **cathode**
- Electrolyte solution -> copper (II) sulfate

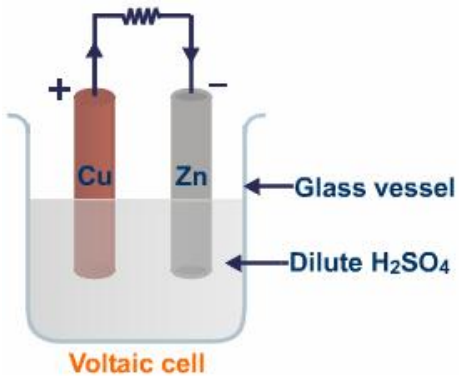


- **Oxidation** takes place at the **anode** -> **more reactive**/less easily discharged metal (**negative** terminal)
- **Reduction** takes place at the **cathode** -> **less reactive**/more easily discharged metal (**positive** terminal)
- Electrons flow from the **more reactive metal to the less reactive metal (anode to cathode)**

Simple cell

- Two different metals in a single electrolyte
- Electrons flow from the **more reactive metal to the less reactive metal**
- **Anode** (-) – **more reactive** (**oxidation**) – the electrons come from here
  - **More reactive -> more likely to oxidize** -> it produces the electrons
- **Cathode** (+) – **less reactive** (**reduction**) – the electrons go here

The further apart the two metals are in the reactivity series, the greater the cell voltage produced.



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