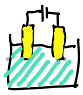
Electrolysis



Electrode → anode → **positive**, attract anions → exception if reactive electrode

↳ cathode → **negative**, attract cations

Inert Electrode → do not react w/ electrolyte and product, provide surface area for e^- transfer

↳ Platinum, graphite

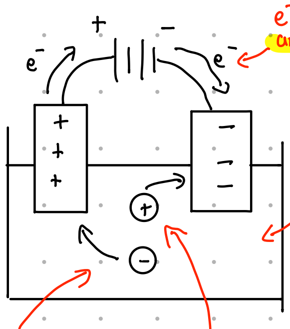
Reactive Electrode

↳ copper, silver, other metals

Electrolyte → molten ionic or aqueous compounds containing mobile ions that conduct electricity

note: only applies to liquids and solutions

- Strong → complete dissociation
  ↳ NaOH (aq), HCl, ...
- weak → partial dissociation
  ↳ aq ammonia, ethanoic acid
- non → don't conduct e^-
  ↳ organic liquid / solutions



e^- flow from anode to cathode

electrolysis (conduction of electricity) stops when no more ions

anions migrate to anode, lose e^- to form neutral atoms/molecules (oxidation)

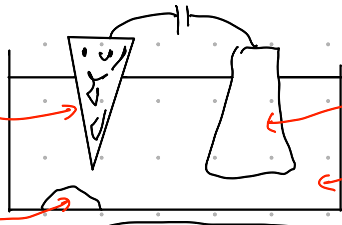
Cations will migrate to cathode and lose e^- to form neutral atoms/molecules (reduction)

Nature of Electrodes

Reactive anodes ionise → dissolve and lose mass instead of discharging anions.

↳ cause cathode to gain mass

Application: Copper Purification



impure copper anode

sludge contain precious metal

very pure copper cathode

any aqueous copper salt

Application: Electroplating

anode: plating metal

cathode: to be plated

Silver → trophy, utensil

Chromium → taps, motorcar

Tin → Tin can

General rules for Observations

1. Check what product is produced, and its state
2. Check if said product has colour
3. If transition metals are involved, check for colour change
4. Check if reactive electrode changes size
5. Check for any insoluble salts that might form in electrolyte

Electrolysis of aqueous ionic compounds

Discharge Explanation Example:

Hydroxide ions are **preferentially** discharged as they **lose electrons more easily** than chloride ions ← Change to gain for cations

For Cl, Br and I, say that while OH^- easier to discharge, mention concentration

General rules for effect on electrolyte

1. Check if there is net difference in concentration of H^+ and OH^- → pH change
2. If colour change in electrolyte, write it down here too
3. Check if there is net concentration change for specific compound

General rules for predicting selective discharge

1. Identify ions (water has H^+ and OH^-)
2. Anode product is always O_2 unless high concentration for Cl, Br, I
3. H_2 gas liberated if cation above H^+ in series
4. Identify remaining ions in solution. They form product

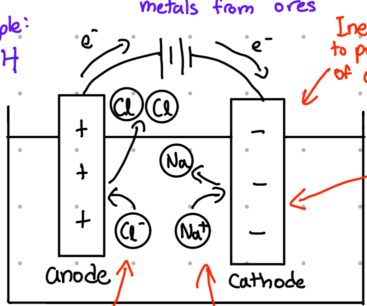
Reactivity Series (↓ ease of discharge)	Product at cathode:
K^+	Hydrogen gas
Na^+	
Ca^{2+}	
Mg^{2+}	
Al^{3+}	
Zn^{2+}	
Fe^{2+}	
Pb^{2+}	
H^+	
Cu^{2+}	copper metal
Ag^+	silver metal

Product at low concentration:	Electrochemical series (↓ ease of discharge)	Product at high concentration:
Oxygen and water	SO_4^{2-}	oxygen and water
	NO_3^-	
	Cl^-	chlorine gas
	Br^-	aqueous bromine
	I^-	aqueous iodine
	OH^-	oxygen and water

Electrolysis of molten binary compounds

↳ application: extraction of reactive metals from ores

Example: NaOH



Inert atmosphere to prevent oxidation of extracted metals

Why graphite electrode used?

1. high melting pt
2. Good electrical conductor
3. Inert

3 bonds, 1 delocalise to conduct

Each chloride ion loses 1 e^- to form Cl atom. 2 Cl atoms combine to form Cl_2 gas which escapes (oxidation)

each Na^+ ion gains 1 e^- from cathode to form Na atom (reduction)

ionic half eqn:	$2Cl^-(l)$ ↳ $Cl_2(g) + 2e^-$	$Na^+(l) + e^-$ ↳ $Na(l)$
product:	Cl_2 gas	molten Na metal
Observation:	Effervescence of pale yellowish-green gas	Grey liquid

Overall eqn: $2NaCl(l) \rightarrow 2Na(l) + Cl_2(g)$

Application: Aluminium Extraction

Al_2O_3 melting pt: 2045°C → too high!

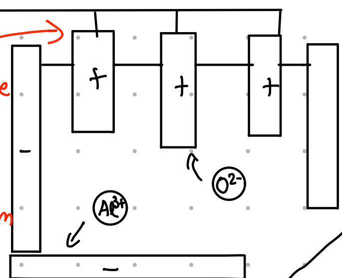
hence, use cryolite (Na_3AlF_6)

↳ melting pt: 1012°C, acts as solvent for Al_2O_3

↳ lowers melting pt of overall mixture to 950°C

↓

mixtures increase boil pt, decrease melt pt



graphite electrode needs regular replacement as oxidised by O_2 produced to form CO_2

don't need inert atmosphere as graphite forms at bottom