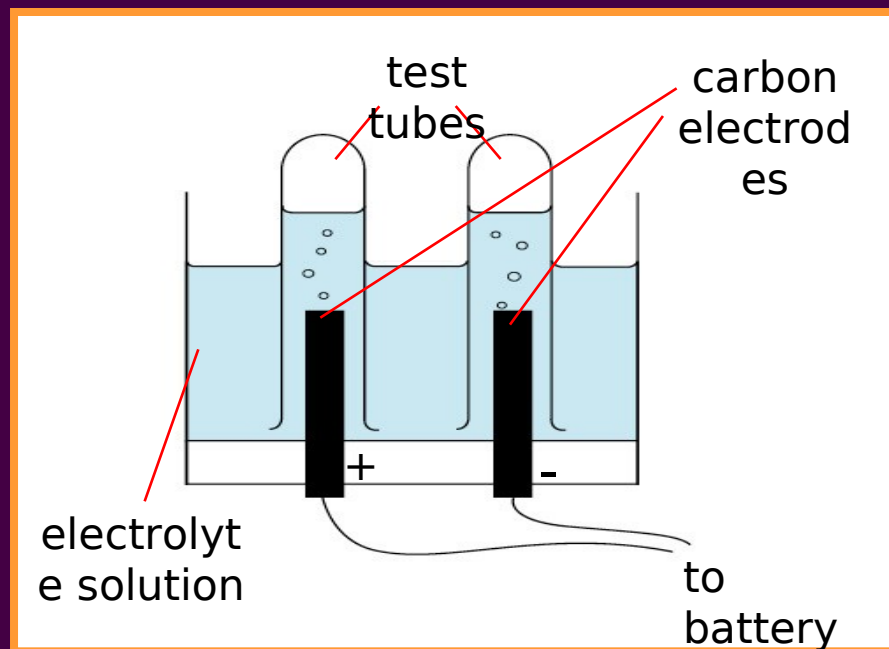


electrolysis of solutions

- solutions can be electrolysed; gases are usually produced
- gases produced can be collected in test tubes; identified later by simple tests (chemical analysis: test for gases)
- more complicated than electrolysis of molten compounds; products at the electrodes can come from the electrolyte or from the water
 - selective discharge of ions
 - reactive electrodes



apparatus for electrolysis of solutions

electrolysis of solutions

selective discharge of ions

- at the cathode:
 - positive ions from the electrolyte are discharged if they are $\text{H}^+(\text{aq})$ ions or ions of less reactive metals such as Cu^{2+} , Pb^{2+} or Ag^+
 - positive ions of reactive metals such as Na^+ , K^+ and Ca^{2+} are not discharged in the presence of water; H^+ ions from water are discharged and H_2 produced
- at the anode:
 - negative ions from the electrolyte are discharged if they are halide ions such as Cl^- , Br^- and I^-
 - SO_4^{2-} and NO_3^- ions are not discharged; OH^- ions from water are discharged and O_2 produced

electrolysis of solutions

selective discharge of ions

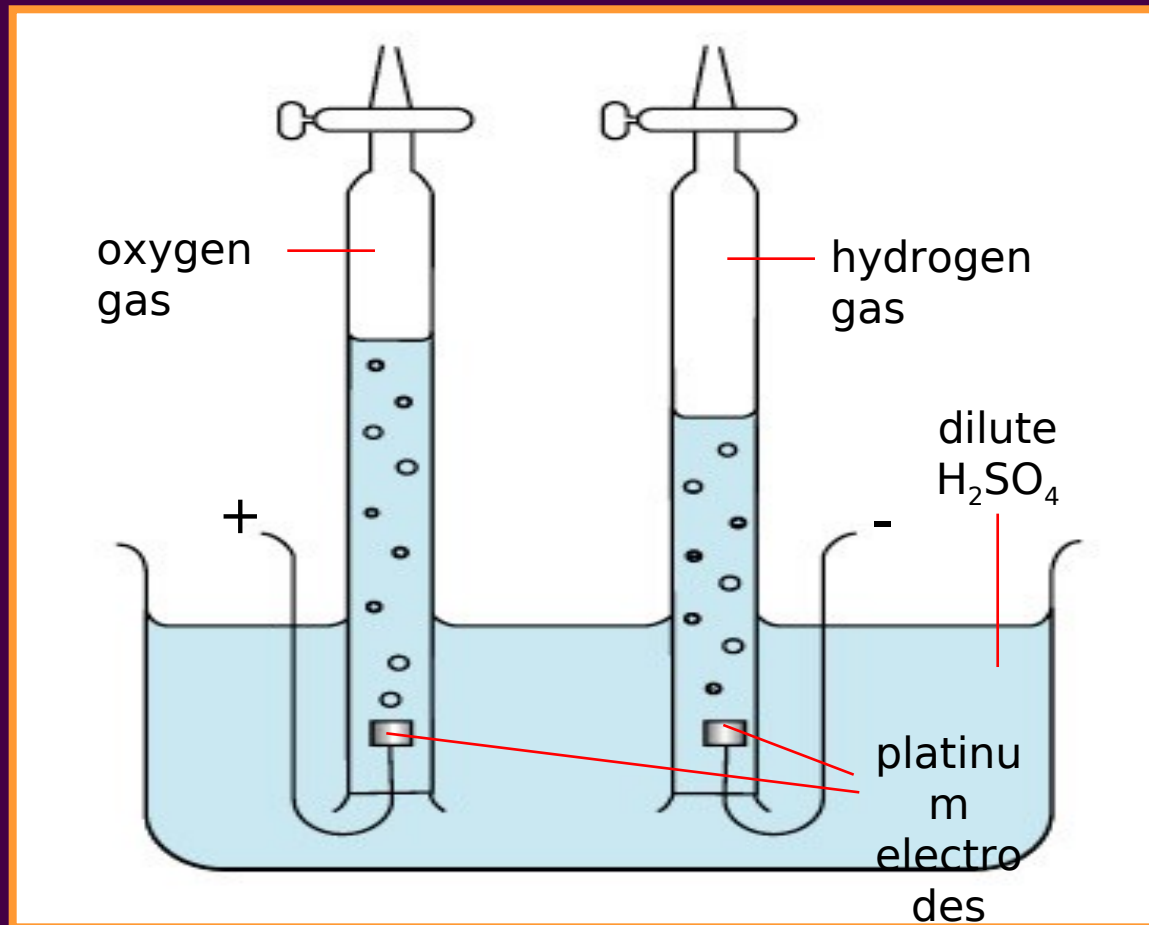
- table shows the electrode products from solutions of ions:

	Cation	Product at Cathode	Anion	Product at Anode
 reactivity of metal decreases ↓	K ⁺ Na ⁺ Ca ²⁺ Mg ²⁺ Al ³⁺	hydrogen from water	Cl ⁻ Br ⁻ I ⁻	chlorine bromine iodine
	Ni ²⁺ Pb ²⁺ Cu ²⁺ Ag ⁺	nickel lead copper silver	SO ₄ ²⁻ NO ₃ ⁻	oxygen from water

electrolysis of solutions

electrolysis of dilute H_2SO_4

- electrolysis of dilute H_2SO_4 :



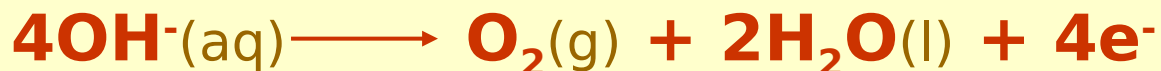
electrolysis of solutions

electrolysis of dilute sulphuric acid

- dilute sulphuric acid contains H^+ , SO_4^{2-} and OH^- ions
- at the cathode, H^+ ions take in electrons to become H_2 molecules; H^+ ions are discharged



- at the anode, OH^- ions are discharged in preference over SO_4^{2-} ; thus giving off oxygen gas



- overall reaction:



electrolysis of solutions

electrolysis of dilute sulphuric acid

- examples of electrolysis of different solutions, using inert electrodes

Electrolyte	Ions in Solution	Product at Cathode	Product at Anode
concentrated aqueous sodium chloride	$\text{Na}^+(\text{aq})$, $\text{Cl}^-(\text{aq})$, $\text{H}^+(\text{aq})$, $\text{OH}^-(\text{aq})$ from the water	hydrogen gas	chlorine gas
dilute sulphuric acid	$\text{H}^+(\text{aq})$, $\text{SO}_4^{2-}(\text{aq})$, $\text{H}^+(\text{aq})$, $\text{OH}^-(\text{aq})$ from the water	hydrogen gas	oxygen gas
aqueous copper(II) sulphate solution	$\text{Cu}^{2+}(\text{aq})$, $\text{SO}_4^{2-}(\text{aq})$, $\text{H}^+(\text{aq})$, $\text{OH}^-(\text{aq})$ from the water	copper metal	oxygen gas

electrolysis of solutions

reactive electrodes

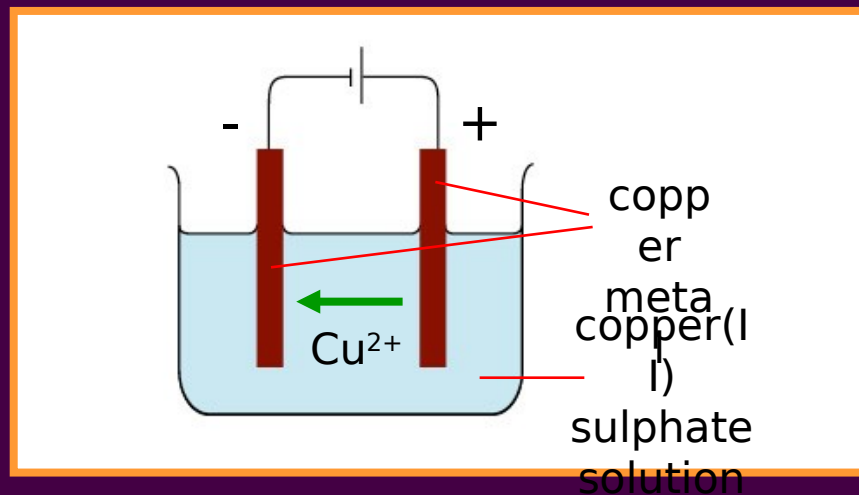
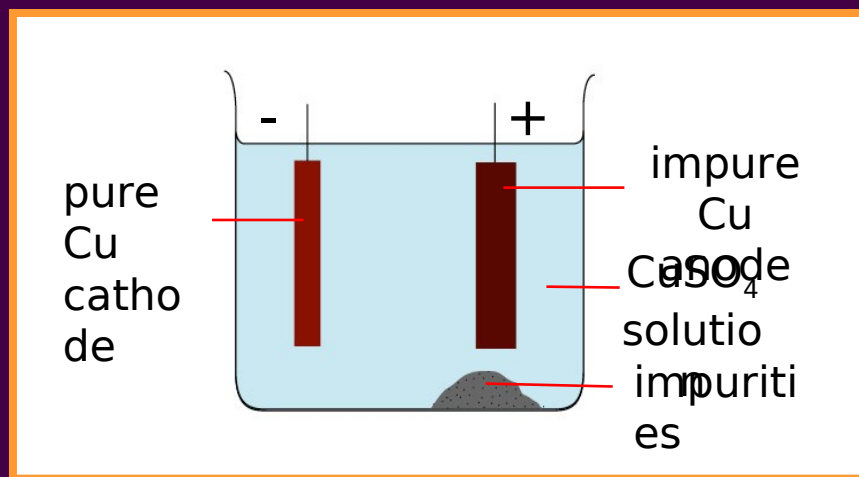
- reactive electrodes can dissolve in electrolyte
- carbon and platinum are inert electrodes; do not react or dissolve in electrolyte

electrolysis of solutions

participating electrodes

- metals such as copper and silver are participating electrodes; they can react or dissolve in the electrolyte
- copper electrodes are used in electrolysis of CuSO_4 solution to refine (purify) copper

Pure copper from the anode dissolves in the electrolyte giving up its valence electrons to the anode. Pure copper is deposited on the cathode; impurities are left behind.



electrolysis of CuSO_4 using Cu electrodes