

Reduction and Oxidation

continued...

How do we get metals?

- Gold, because it is so unreactive, is found as the native metal and not as a compound. It does not need to be chemically extracted from its ore.
- Copper can be extracted from copper oxide by heating in a furnace, a process called smelting.
- Who can remember which metals are reactive?
- How do we extract reactive metals?

Reactivity Series

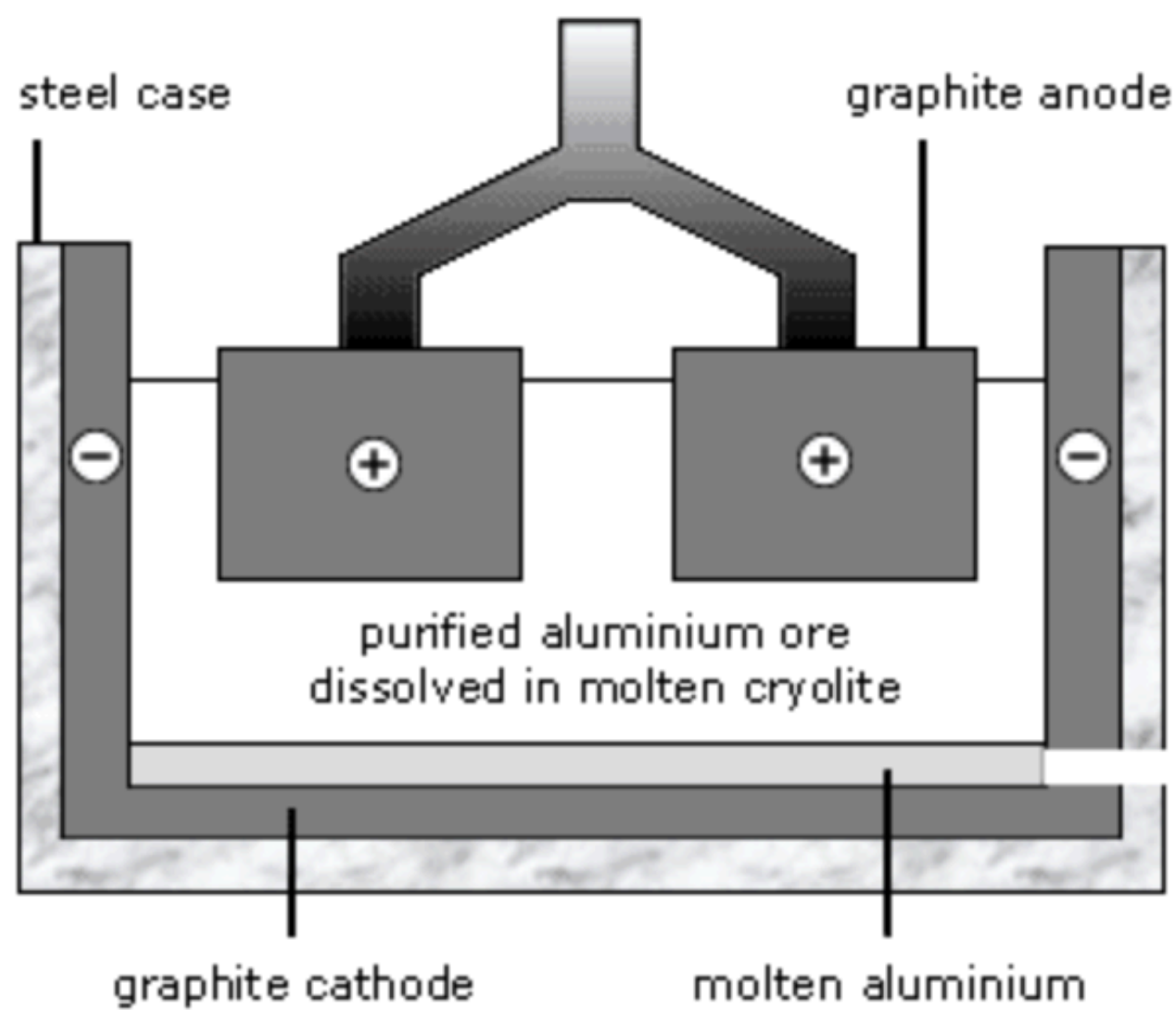
- potassium
- sodium
- calcium
- magnesium
- aluminium
- **carbon**
- zinc
- iron
- tin
- lead
- **hydrogen**
- copper
- silver
- gold
- platinum

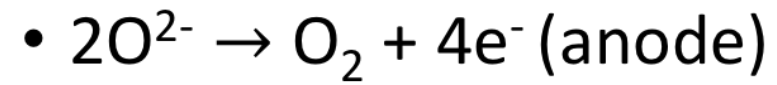
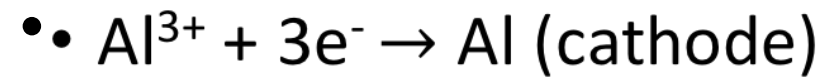
How do we get reactive metals?

- To extract reactive metals from their ores (ores are naturally occurring rocks that contain metal or metal compounds in sufficient amounts to make it worthwhile extracting them) we need to.....
- **Use electrolysis (the process by which ionic substances are broken down into simpler substances using electricity. During electrolysis, metals and gases may form at the electrodes.)**

aluminium oxide (Al_2O_3)

- We use electrolysis to extract aluminium oxide (Al_2O_3). We saw this on an industrial scale last week.
- Draw and label a diagram to show how electrolysis of aluminium oxide works.
- Write chemical equations to describe what happens at each electrode.





- We saw in the video last week that the aluminium oxide had to be made molten in order for the process to work. Why?
- The ions need to be able to flow (in the liquid phase)
- I said last week that aluminium oxide wasn't soluble in water but aluminium sulfate is. Can we use electrolysis to extract aluminium from aluminium sulfate (aq)?

- If I try to electrolyse aluminium sulfate (aq) we get hydrogen at the cathode and oxygen at the anode.
- Where does the hydrogen and oxygen come from?
- Water

Water

- Water exists as a mixture of the molecule H_2O and the ions OH^- and H^+
- $\text{H}_2\text{O} (\text{l}) \rightleftharpoons \text{H}^+ (\text{aq}) + \text{OH}^- (\text{aq})$
- At 298 K there are 250 million times as many water molecules as OH^- and H^+ ions combined!

- Write equations to describe the processes that take place at the cathode and anode when we try to electrolyse aluminium sulfate (aq)
- $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ (cathode)
- $4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$ (anode)
- Why do we get hydrogen at the cathode instead of aluminium?

- potassium
- sodium
- calcium
- magnesium
- aluminium
- **carbon**
- zinc
- iron
- tin
- lead
- **hydrogen**
- copper
- silver
- gold
- platinum

Reactivity Series

Hydrogen is less reactive than aluminium and so hydrogen is produced at the cathode instead.

electrolyte

cathode

anode

Molten lead bromide

lead

bromine

Molten potassium chloride

potassium

chlorine

Calcium nitrate (aq)

hydrogen

oxygen

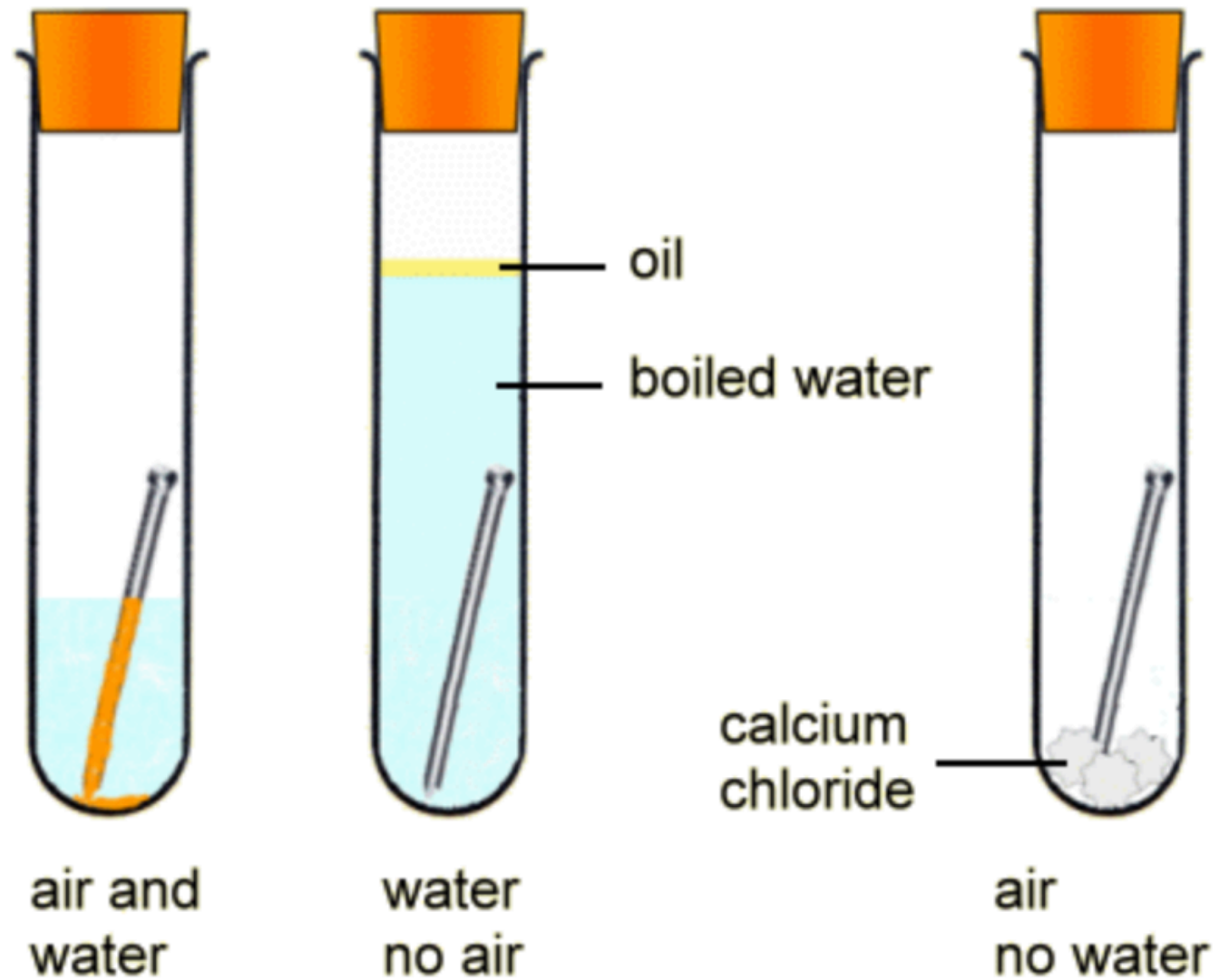
Copper chloride (aq)

copper

chlorine

Iron

- When we leave an iron nail out in the rain, what happens?
- It rusts.



- What does this test show us we need for rusting?

- In order for iron to rust (form iron oxide), we need oxygen and water. Water acts as a catalyst.
- Write an equation for the rusting of iron.
- $\text{Fe} + \text{O}_2 \rightarrow \text{Fe}_2\text{O}_3$
- $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$
- Is iron being oxidised or reduced?
- oxidised

How can we prevent rusting?

- We can paint iron so that oxygen cannot react with the metal
- We could cover the metal in grease so that oxygen cannot react with the metal.
- We can cover the metal in another metal so that it cannot react with oxygen. How?

Electroplating

- Electrolysis is used to electroplate objects. This is useful for coating a cheaper metal with a more expensive one, such as copper or silver.
- The **electrolyte** should be a solution of the coating metal, such as its metal nitrate or sulfate
- The object that is to be electroplated should be the **negative/positive electrode?**
- **Negative electrode (cathode)**

Electroplating practical

- We are going to coat iron nails with zinc.
- We are going to use aqueous zinc sulfate solution.
- Even though zinc is more reactive than hydrogen, zinc will be produced at the electrode instead of hydrogen (This is an exception to the rule we learned this lesson).