Electrolysis

The specification:

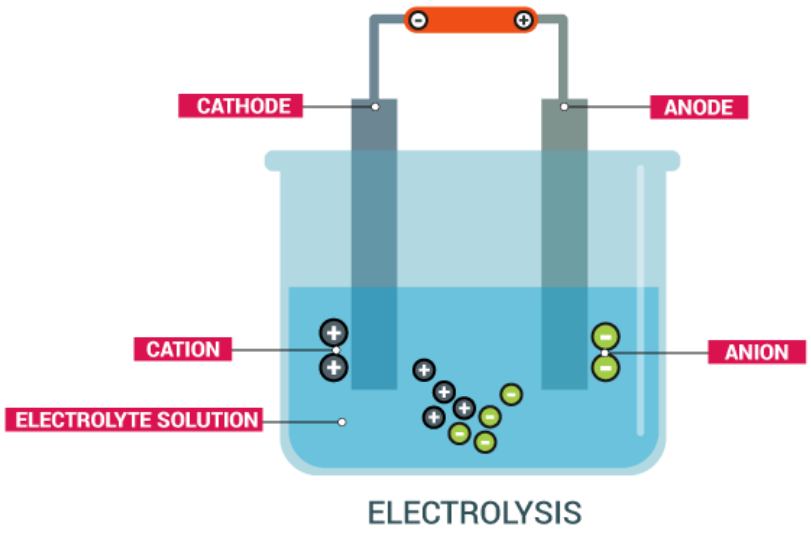
→ Techniques and procedures in the electrolysis of aqueous solutions; half equation for the process occurring at electrodes in the electrolysis of molten salts and aqueous solutions:

Formation of oxygen or a halogen or metal ions at the anode

Formation of hydrogen or a metal at the cathode.

What is electrolysis?

Electrolysis when there is electricity that passes through a molten or aqueous ionic compound. This will break down compounds into different elements at the different electrodes. Because the charged ions are free to move, and this is because molten ionic compounds dissociate letting the ions to move to the oppositely charged electrodes this creates a complete circuit.



Electrodes are made of graphite or platinum as it is inert (so do not react with the elements)

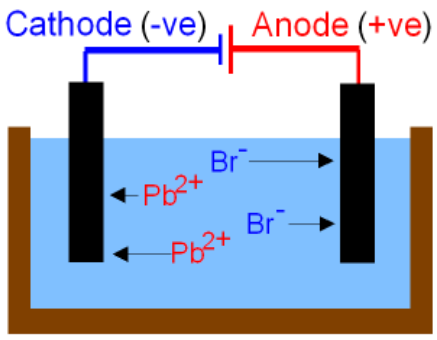
As you can see on this diagram you have the cathode which is negative and therefore the cation is positive as it will get attracted by the opposite charge. The anode will be positive and the anion is going to be negative.

Study tip!

Cations migrate to the cathode and the anions to the anode.

Electrolysis of molten compounds:

As we saw before, an Ionic compound can conduct electricity as a liquid but not when it is a solid because there are no electrons free to move. We can use the example of Lead bromide (PbBr2) as an ionic compound. We know that the lead is Pb2+ and there is positive so this will migrate to the negative electrode, the cathode. The 2Br- is negative and therefore will want to migrate to the positive electrode, the anode.



The half equation for this is:

Pb2+(l) +2e- → Pb(l) For the lead at the cathode

2Br-(l) → Br2(g)+2e- For the bromine at the anode

Check the section for half equation if you need more help with this.

So it is easy to predict the products at the different electrodes when it is molten. The product at the cathode will be a metal and the product at the anode will be a non-metal apart from hydrogen.

Electrolysis of solution

This is much easier to to carry out as the ionic compound is very energy intensive and in solution it is more efficient as in water, the ionic compounds are free to move more. But now to predict the product it is a bit more hard as before there was no competition but now there is water as well that act on the electrodes as the half equation of water at the electrodes is this:

2H2o(l) +2e- → 2OH-(aq) + H2(g) This is water at the cathode, so water will be reduced here as it gains electrons.

2H2o(l) → o2(g)+4H+(aq)+4e- This is water at the anode, so the water will be oxidised as it will lose some electrons.

So as you can see the water will break making 4 types of ions present in the solution. Only one species can react at each electrode.

Rules for the cathode:

If + ions (metals) are group 1,2, aluminium or acids then hydrogen will be produced. If +ions (metals) are less reactive than hydrogen, the metal will be produced.

Rules for the anode:

If -ions are halogens like Cl-,Br- or I- then the halogens will be produced. If -ions are not an halogen like So42-,NO3- then oxygen will be produced.

Another possibility at the anode is that if the electrodes are the same as the solution like if you have electrodes of copper and have a solution of copper compound, the metal anode will lose mass because the copper atoms change to copper ions and go into solution.