Cambridge Assessment International Education

The electrolysis of molten zinc chloride

Transcript

Here is the reactivity series.

Highly reactive metals, above carbon, cannot be obtained by metal extraction. Instead, they are obtained by a process known as electrolysis. This is the decomposition of a substance using electricity.

For example, sodium metal can be obtained industrially by the electrolysis of molten sodium chloride. Electrical energy from a direct current supply, decomposes the molten sodium chloride into its elements. This procedure cannot be performed in a school laboratory because the melting point of sodium chloride is too high at 801 degrees Celsius.

In this experiment, you are going to obtain zinc metal by the electrolysis of molten zinc chloride. Zinc chloride has a lower melting point (290 degrees Celsius), which means it is more feasible to be carried out in a school laboratory.

First, place a porcelain crucible on a pipe clay triangle supported by a metal tripod. Ensure that the crucible is seated firmly and that the the tripod is placed on a heat-proof mat.

The graphite rods should be firmly held in the rubber bung at one end. The bung is then firmly held in a clamp and the electrodes connected by crocodile clips. The carbon electrode connected to the negative terminal of the power pack is the cathode. The red lead connecting the electrode to the positive terminal becomes the anode.

Test that the external circuit is connected properly, by bridging the electrodes with a metal object. The bulb should light up.

Lower the external circuit assembly into the crucible, until the electrodes are almost touching the bottom of it.

Using a spatula, carefully fill the crucible with zinc chloride and compact it down. Then add more of the solid so that there is plenty in the crucible. Note that the bulb is not lit at this stage.

Start heating the crucible with a Bunsen burner. Ensure that the flame is not too big, and that it is focused on the bottom of the crucible.

The zinc chloride is now melting. The ammeter is now showing a reading and the bulb has lit up. This means that a current is now flowing in the external circuit and that electrolysis has begun. Bubbles of chlorine can be seen forming at the anode.

Test the gas produced with damp litmus paper. It quickly becomes bleached confirming that the gas is chlorine.

Continue the electrolysis for about 15 minutes with the fume cupboard hood down.

Now turn the power off. Remove the Bunsen burner and raise the electrode assembly.

Allow the crucible to cool for 5-10 minutes.

Once cool, lift the crucible and plunge it into a beaker of cold water. Make sure you use tongs in case it is still hot.

The contents of the beaker are filtered leaving a solid residue. The filter paper is allowed to dry.

The metallic residue produced can be tested for conductivity. As the bulb lights up the residue is confirmed as a metal.

The compound we started with was zinc chloride. As we have already proved that chlorine was evolved at the anode through the bleaching of the litmus paper, so it makes sense that this metal is zinc.

Molten zinc chloride has been decomposed into its elements using electricity. At the cathode, zinc ions are reduced to zinc. And at the anode, chloride ions are oxidised to chlorine.

These half-reactions can be combined to cancel the electrons. This gives the overall equation for the reaction.

Therefore, by using electricity, the non-spontaneous reaction of decomposing molten zinc chloride into its elements has been carried out.