Extraction of Aluminium

Aluminium is extracted from its ore BAUXITE, $\text{Al}_2\text{O}_3$

This cannot be done by reduction with carbon because

Before electricity was invented, aluminium was made by a displacement reaction between a solution of its chloride and sodium.
The equation was

\[
\text{this made aluminium more expensive than gold!}
\]

Nowadays, we can use ELECTROLYSIS to extract the metal from its ore.

In order to electrolyse an ionic compound, what has to be done to it?

There is a problem here: Aluminium oxide has a very high melting point (2030°C). This makes it too expensive to carry out electrolysis at this temperature

The solution is to ____________________________

The solvent that is used is a mineral called CRYOLITE. It has a melting point of <1000°C

Electrolysis theory: $\text{Al}_2\text{O}_3(\ell)$

What is formed at the -ve electrode (write an equation)

What is formed at the +ve electrode (write an equation)
Annotate the diagram attached

1. The molten bauxite ore dissolved in cryolite is placed in a huge tank lined with graphite and surrounded by steel. This graphite is attached to the negative electrode (it is made the cathode).

2. Aluminium ions are attracted to this and form liquid Aluminium. This sinks to the bottom and is tapped off.

3. Graphite anodes are suspended in the molten ore. Oxygen ions are attracted here and bubbles of oxygen gas are formed.

Some key points

1. BAUXITE is ____________________

2. Why is CRYOLITE used?

3. Why do you think the carbon anodes have to be replaced regularly?

4. What is the main expense in this process?
Extraction of Aluminium
Aluminium
Uses and Recycling

Uses

Aluminium is exceptionally useful. Its properties include

1. Low density (light)
2. Can be alloyed to make it strong
3. Good conductor of heat
4. Good conductor of electricity
5. Very malleable
6. Does not rust like iron

Its uses thus include

➢ Food containers
➢ Building and construction
➢ Aeroplane parts
➢ Wrapping foil
➢ High tension power cables

Recycling

Extracting aluminium is an expensive process. The electricity used in the main cost but higher temperatures also cost money. Recycling also conserves the natural resources of bauxite

Aluminium has a low melting point compared with other transition metals and can be easily separated from them. This does tend to reduce its quality, though, so the recycled metal is not used for more important jobs such as aircraft alloy.
Extracting Aluminium

Q1: Aluminium is the most abundant metal in the Earth’s crust.
   a) i) Circle the correct word:
       The most common aluminium ore is bauxite / argyrite.
   ii) When this ore is mined and purified, which compound is obtained?
       Give its name and formula.
       Name .............................................. Formula ..............................................

   b) Why can’t aluminium be extracted by reduction with carbon?

   c) Although it’s very common, aluminium was not discovered until 1825. Suggest why.

Q2: a) Indicate whether the following statements are true or false.
    i) Ionic substances can only be electrolysed if molten or in solution.  True False
    ii) In the extraction of aluminium the electrolyte is molten aluminium metal. True False
    iii) Aluminium oxide is dissolved in molten cryolite before electrolysis begins. True False
    iv) Copper electrodes are used in the extraction of aluminium by electrolysis. True False
    v) Aluminium is formed at the anode. True False

   b) Write out a correct version of each false statement.

Q3: The extraction of aluminium by electrolysis is a redox reaction.
   a) Write balanced half-equations for the reactions at the electrodes.
      Cathode: ..............................................
      Anode: ..............................................

   b) Use the half-equations to help explain why this process is called a ‘redox’ reaction.

Module C3 — The Periodic Table
Extracting Aluminium

Q4 The diagram shows the set-up of the equipment used to extract aluminium by electrolysis.

Cathode  Anode

Molten aluminium metal

a) Why is the aluminium formed as a liquid?

b) What substance is formed at the anode?

c) Why does the anode need to be replaced frequently?

Q5 Bauxite, mined in Jamaica, is shipped to Canada to be processed into aluminium because Canada has abundant hydroelectric power.

a) Give three major costs, apart from the mining of the ore, involved in the extraction of aluminium.
   1. ..........................................................
   2. ..........................................................
   3. ..........................................................

b) Why does it make economic sense to ship the ore to Canada?

Top Tips: In general, things that are common and easy to get at are cheap. Like potatoes, say. But you can't make drink cans or aeroplane fuselages from potatoes — you need a nice lightweight metal, like aluminium. Aluminium is as common a metal as you can get but it's not that cheap because it's expensive to extract — electrolysis costs a lot. (Potatoes, on the other hand, are very easy to extract — you find a spade and just get digging — no pricey electricity needed.)

Module C3 — The Periodic Table