

Electrochemistry*(Past Year Topical Questions 2010-2015)*May/June 2010 (32)

- 7 Aluminium was first isolated in 1827 using sodium.

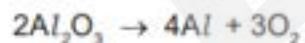


Aluminium, obtained by this method, was more expensive than gold.

- (a) Suggest an explanation why aluminium was so expensive.

.....
..... [1]

- (b) The modern method for extracting aluminium is the electrolysis of a molten electrolyte, aluminium oxide dissolved in cryolite. The aluminium oxide decomposes.

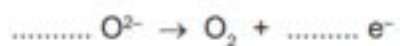


Both electrodes are made of carbon.

- (i) Give **two** reasons why the oxide is dissolved in cryolite.

.....
.....
..... [2]

(ii) Complete the ionic equation for the reaction at the anode.



[2]

(iii) Why do the carbon anodes need to be replaced frequently?

.....
..... [1]

(c) The electrolysis of a molten electrolyte is one method of extracting a metal from its ore. Other methods are the electrolysis of an aqueous solution and the reduction of the oxide by carbon. Explain why these last two methods cannot be used to extract aluminium.

electrolysis of an aqueous solution

.....

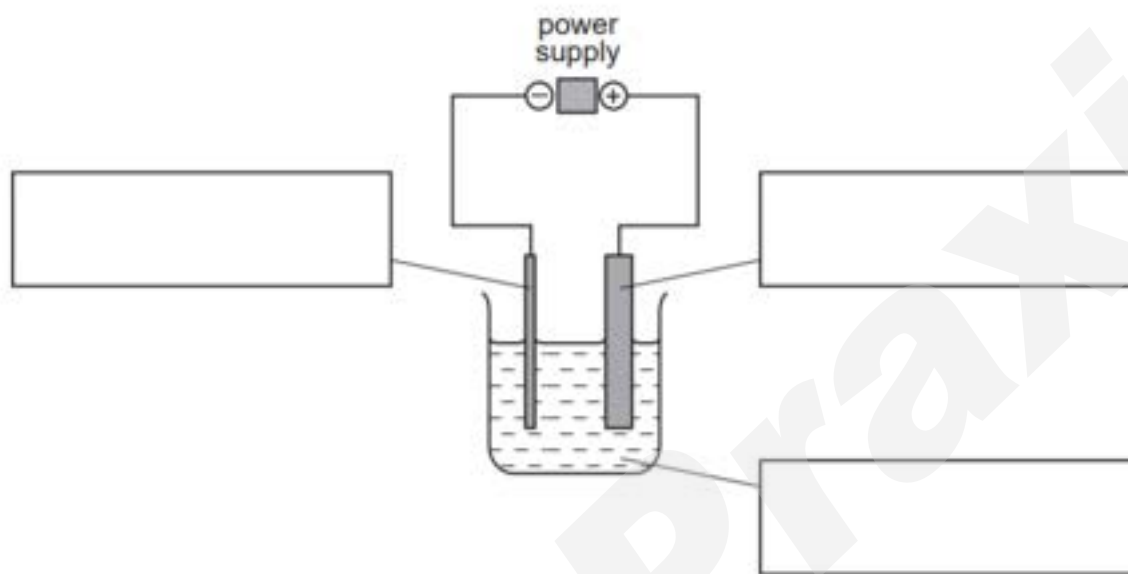
using carbon

..... [2]

[Total: 8]

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- (iii) Copper oxide is reduced to copper which is then refined by electrolysis. Label the diagram of the apparatus which could be used to refine copper.



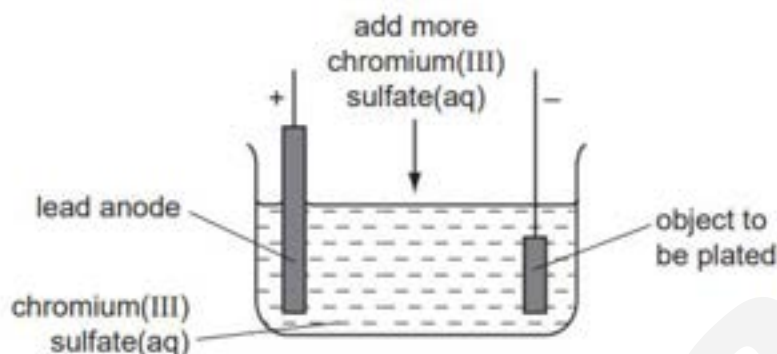
[3]

- (iv) Give one use of copper, other than making alloys.

..... [1]

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- (b) Chromium is used to electroplate steel objects. The diagram shows how this could be done.



- (i) Give **two** reasons why steel objects are plated with chromium.

.....
 [2]

- (ii) The formula of the chromium(III) ion is Cr^{3+} and of the sulfate ion is SO_4^{2-} . Give the formula of chromium(III) sulfate.

..... [1]

- (iii) Write the equation for the reaction at the negative electrode (cathode).

..... [2]

- (iv) A colourless gas, which relights a glowing splint, is formed at the positive electrode (anode). Name this gas.

..... [1]

- (v) During electrolysis, it is necessary to add more chromium(III) sulfate but during copper-plating using a copper anode, it is not necessary to add more copper(II) sulfate. Explain.

.....
.....
..... [2]

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- (b) Aqueous tin(II) sulfate is electrolysed using carbon electrodes. This electrolysis is similar to that of aqueous copper(II) sulfate using carbon electrodes.

- (i) What is the product at the negative electrode (cathode)?

..... [1]

- (ii) Write the equation for the reaction at the positive electrode (anode).

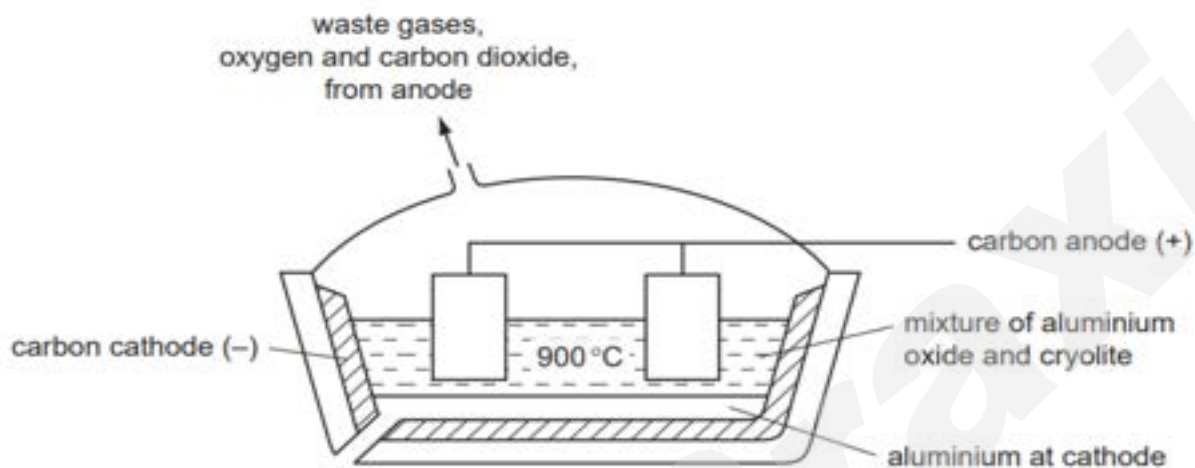
..... [2]

- (iii) Name the acid formed in this electrolysis.

..... [1]

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- 3 Aluminium is extracted by the electrolysis of a molten mixture of alumina, which is aluminium oxide, and cryolite.



- (a) (i) Alumina is obtained from the main ore of aluminium.
Name this ore.

..... [1]

- (ii) Explain why it is necessary to use a mixture, alumina and cryolite, rather than just alumina.

.....
 [2]

- (iii) Copper can be extracted by the electrolysis of an aqueous solution. Suggest why the electrolysis of an aqueous solution cannot be used to extract aluminium.

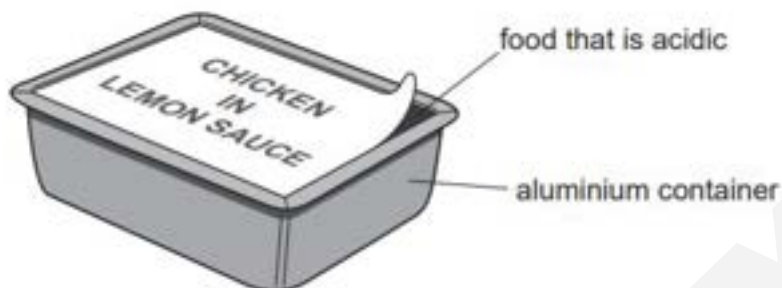
.....
.....
..... [2]

- (b) The ions which are involved in the electrolysis are Al^{3+} and O^{2-} . The products of this electrolysis are given on the diagram. Explain how they are formed. Use equations where appropriate.

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.....
..... [4]

(c) The uses of a metal are determined by its properties.

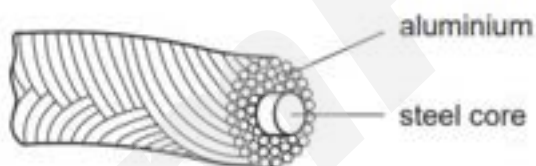
(i) Foods which are acidic can be supplied in aluminium containers.



Explain why the acid in the food does not react with the aluminium.

.....
..... [1]

(ii) Explain why overhead electrical power cables are made from aluminium with a steel core.



.....
..... [3]

[Total: 13]

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- 4 The ore of aluminium is bauxite which is impure aluminium oxide. Alumina, pure aluminium oxide, is obtained from bauxite. Aluminium is formed at the cathode when a molten mixture of alumina and cryolite, Na_3AlF_6 , is electrolysed.

(a) (i) Name **two** products formed at the anode in this electrolysis.

..... [2]

(ii) All the aluminium formed comes from the alumina not the cryolite. Suggest **two** reasons why the electrolyte must contain cryolite.

.....
..... [2]

(b) The purification of bauxite uses large amounts of sodium hydroxide.

(i) Describe the chemistry of how sodium hydroxide is made from concentrated aqueous sodium chloride. The description must include at least one ionic equation.

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.....
.....
..... [5]

(ii) Making sodium hydroxide from sodium chloride produces two other chemicals. Name these two chemicals and state one use of each chemical.

chemical

use

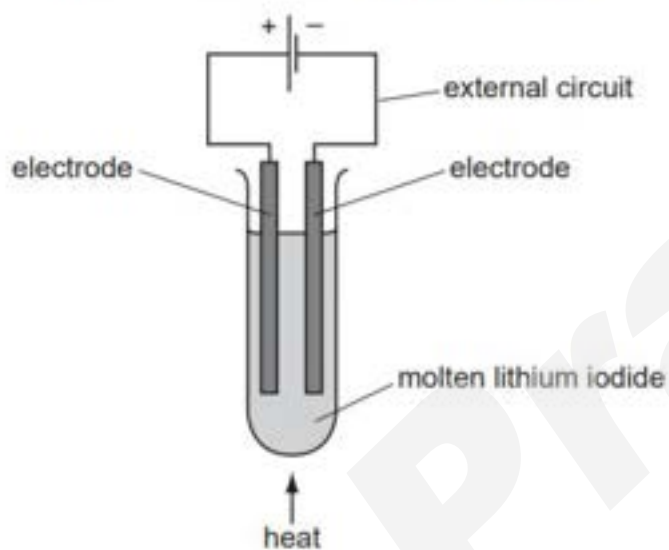
chemical

use [2]

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- 6 During electrolysis, ions move in the electrolyte and electrons move in the external circuit. Reactions occur at the electrodes.

(a) The diagram shows the electrolysis of molten lithium iodide.



- (i) Draw an arrow on the diagram to show the direction of the electron flow in the external circuit. [1]
- (ii) Electrons are supplied to the external circuit. How and where is this done?

.....
..... [2]

- (iii) Explain why solid lithium iodide does not conduct electricity but when molten it is a good conductor.

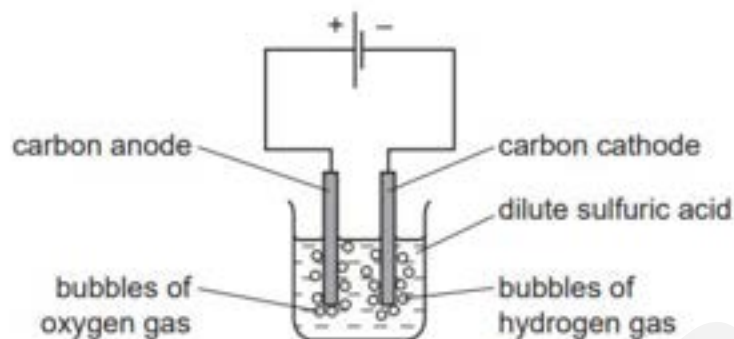
.....
..... [1]

- (b) The results of experiments on electrolysis are shown in the following table. Complete the table. The first line has been done as an example.

electrolyte	electrodes	product at cathode	product at anode	change to electrolyte
molten lithium iodide	carbon	lithium	iodine	used up
aqueous copper(II) sulfate	platinum		oxygen	
concentrated aqueous potassium chloride	carbon		chlorine	

[4]

- (c) The diagram below shows the electrolysis of dilute sulfuric acid. Hydrogen is formed at the negative electrode (cathode) and oxygen at the positive electrode (anode) and the concentration of sulfuric acid increases.



The ions present in the dilute acid are $\text{H}^+(\text{aq})$, $\text{OH}^-(\text{aq})$ and $\text{SO}_4^{2-}(\text{aq})$.

- (i) Write an equation for the reaction at the negative electrode (cathode).

..... [2]

- (ii) Complete the equation for the reaction at the positive electrode (anode).



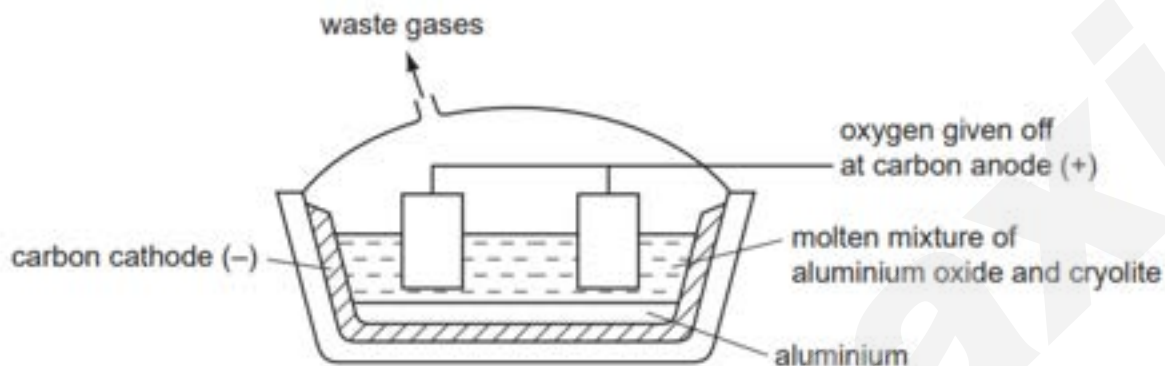
- (iii) Suggest an explanation of why the concentration of the sulfuric acid increases.

..... [1]

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6 Aluminium is an important metal with a wide range of uses.

(a) Aluminium is obtained by the electrolysis of aluminium oxide dissolved in molten cryolite.



(i) Solid aluminium oxide is a poor conductor of electricity. It conducts either when molten or when dissolved in molten cryolite. Explain why.

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..... [2]

(ii) Why is a solution of aluminium oxide in molten cryolite used rather than molten aluminium oxide?

..... [1]

(iii) Explain why the carbon anodes need to be replaced periodically.

..... [1]

(iv) One reason why graphite is used for the electrodes is that it is a good conductor of electricity. Give another reason.

..... [1]

(b) Aluminium is used to make food containers because it resists corrosion. Explain why it is not attacked by the acids in food.

.....
..... [2]

(c) Aluminium is used for overhead power (electricity) cables which usually have a steel core.



(i) Give **two** properties of aluminium which make it suitable for this use.

.....
..... [2]

(ii) Explain why the cables have a steel core.

.....
..... [1]

[Total: 10]

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- (iii) A method being developed to produce iron with lower emissions of carbon dioxide is by electrolysis. Hematite, Fe_2O_3 , is dissolved in molten lithium carbonate and electrolysed. The ore is split into its constituent elements.

Write an equation for the reaction at the negative electrode (cathode).

.....

Complete the equation for the reaction at the positive electrode (anode).



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- (c) The solution of zinc sulfate is electrolysed using inert electrodes.
This electrolysis is similar to that of copper(II) sulfate with inert electrodes.

(i) Write the equation for the reaction at the negative electrode (cathode).

..... [1]

(ii) Complete the equation for the reaction at the positive electrode (anode).



(iii) The electrolyte changes from zinc sulfate to

..... [1]

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- (b) Chlorine is made by the electrolysis of concentrated aqueous sodium chloride. Describe this electrolysis. Write ionic equations for the reactions at the electrodes and name the sodium compound formed.

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..... [5]

May/June 2014 (33)

- 7 Aluminium is obtained from purified alumina, Al_2O_3 , by electrolysis.

- (a) Alumina is obtained from the main ore of aluminium. State the name of this ore.

..... [1]

- (b) Describe the extraction of aluminium from alumina. Include the electrolyte, the electrodes and the reactions at the electrodes.

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..... [6]

(c) Aluminium is resistant to corrosion. It is protected by an oxide layer on its surface. The thickness of this oxide layer can be increased by anodising.

(i) State a use of aluminium due to its resistance to corrosion.

..... [1]

(ii) Anodising is an electrolytic process. Dilute sulfuric acid is electrolysed with an aluminium object as the anode. The thickness of the oxide layer is increased. Complete the equations for the reactions at the aluminium anode.

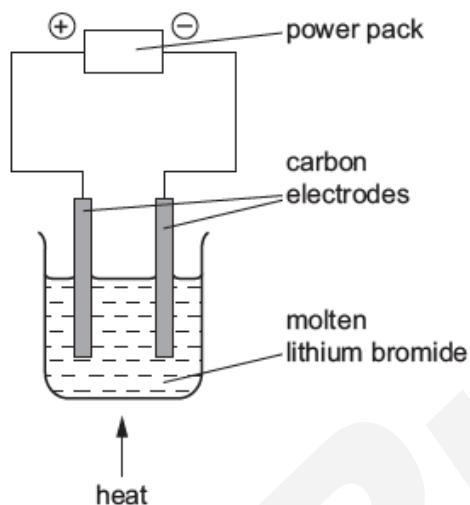


[Total: 12]

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3 Lithium bromide is an ionic compound. It can be electrolysed when it is molten or in aqueous solution. It cannot be electrolysed as a solid.

(b) The diagram shows the electrolysis of molten lithium bromide.



(i) Mark on the diagram the direction of the electron flow. [1]

(ii) Write an ionic equation for the reaction at the negative electrode (cathode).

..... [1]

(iii) Write an ionic equation for the reaction at the positive electrode (anode).

..... [2]

(iv) Which ion is oxidised? Explain your answer.

.....

..... [2]