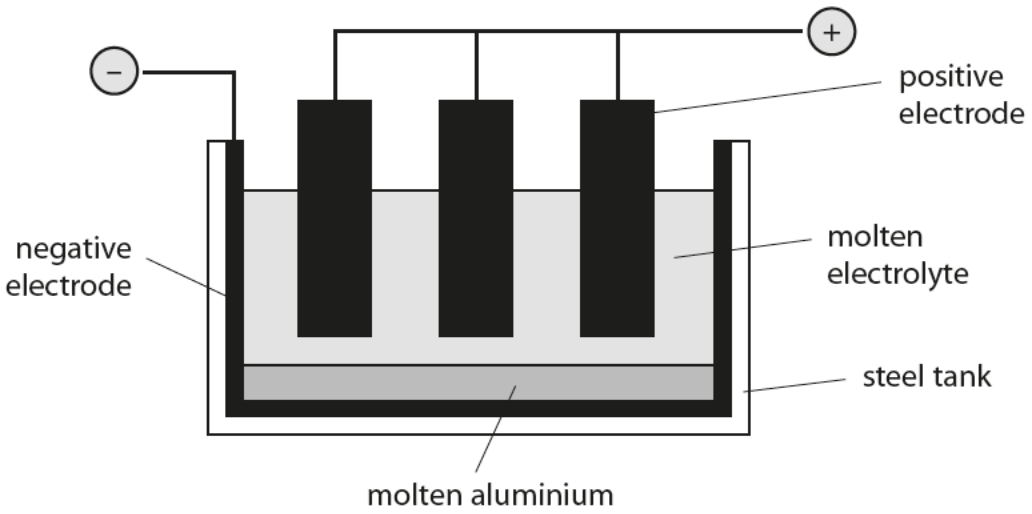
1 This question is about the extraction and uses of aluminium.

(a) Aluminium is extracted from aluminium oxide by electrolysis.



What are the electrodes made of?

(2)

Negative electrode .....

Positive electrode .....

(b) (i) Explain why the operating temperature would need to be very high if pure aluminium oxide were used as the electrolyte.

(1)

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.....

(ii) Describe how the operating temperature is kept low.

(1)

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(c) The ionic half-equation for the reaction at the negative electrode is

$$Al^{3+} + 3e^- \rightarrow Al$$

What type of reaction is occurring at the negative electrode?

Explain your answer.

(2)

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(d) The waste gases escaping from the electrolysis cell contain carbon dioxide.

Describe how the carbon dioxide is formed.

(2)

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(e) Aluminium is used to make cans for food and drinks.



State two properties of aluminium that make it suitable for this use.

You should not refer to cost in your answers.

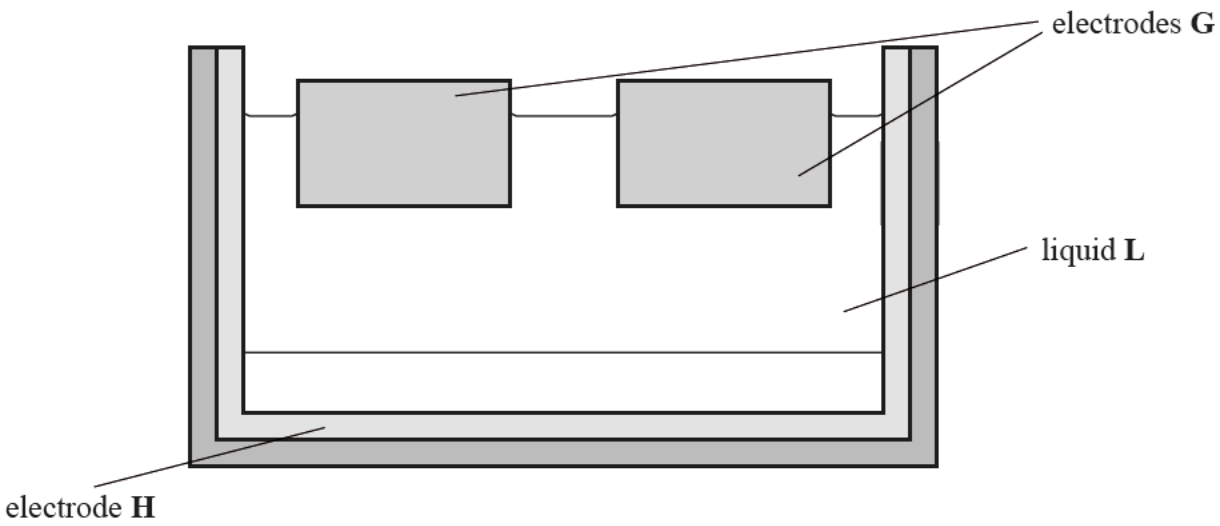
(2)

1 .....

2 .....

(Total for Question 1 = 10 marks)

2 The diagram shows how aluminium is extracted in industry.



(a) (i) Name the process used to extract aluminium.

(1)

(ii) Identify the element used to make the electrodes labelled **G**.

(1)

(iii) State whether electrode **H** is positive or negative.

(1)

(iv) Liquid **L** contains aluminium oxide and one other substance.

Name this other substance and give **one** reason for its use in the extraction of aluminium.

(2)

Other substance

Reason for use

(b) The product formed at electrode **G** reacts with the electrode to form carbon monoxide and carbon dioxide.

(i) Identify this product.

(1)

(ii) State why carbon monoxide is poisonous.

(1)

(iii) Describe a simple chemical test, and its result, for carbon dioxide.

(2)

Test

Result

(c) The uses of aluminium depend on its structure and physical properties.

(i) The strength of solid aluminium depends on the electrostatic force of attraction between two types of particle in its structure.

Name these two types of particle.

(2)

and

(ii) Aluminium is described as ductile because it can easily be pulled into a wire. Explain, in terms of its structure, why it is ductile.

(2)

(iii) Explain, in terms of its structure, why aluminium is a good conductor of electricity.

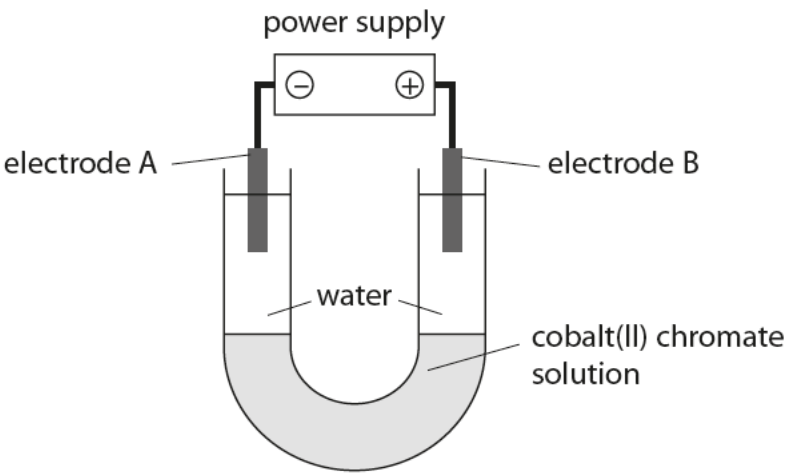
(2)

(iv) State a property that makes aluminium suitable for manufacturing aircraft bodies.

(1)

(Total for Question 2 = 16 marks)

3 The apparatus shown in the diagram can be used to investigate the colours of the cobalt(II) ion (Co^{2+}) and the chromate ion (CrO_4^{2-}) in cobalt(II) chromate.



These are the results of the experiment.

- a pink colour moves towards electrode A
- a yellow colour moves towards electrode B

(a) Explain how the results show that the chromate ion is yellow.

(2)

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(b) (i) Chromate ions in aqueous solution can be converted into dichromate ions ($Cr_2O_7^{2-}$) by the addition of hydrogen ions.

Balance the equation that represents this reaction.

(1)

..... $CrO_4^{2-}(aq)$ + ... $H^+(aq)$ → ..... $Cr_2O_7^{2-}(aq)$ + ... $H_2O(l)$

(ii) Which solution is a source of hydrogen ions for this reaction?

(1)

☒ **A** $H_2O_2(aq)$

☒ **B** HCl(aq)

☒ **C** NaOH(aq)

☒ **D** $NH_3(aq)$

(c) When aqueous potassium chromate is added to aqueous lead(II) nitrate, a bright yellow precipitate is formed.

(i) Complete the equation for the reaction by inserting the missing state symbols.

$$K_2CrO_4(\ldots\ldots) + Pb(NO_3)_2(\ldots\ldots) \rightarrow 2KNO_3(aq) + PbCrO_4(\ldots\ldots)$$

(1)

(ii) Describe how you could obtain a pure, dry sample of the insoluble solid from the final reaction mixture.

(3)

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(Total for Question 3 = 8 marks)