WJEC Chemistry GCSE

6: Reactivity series and Extraction of Metals

Practice Questions

England Specification

1. The order of reactivity of some elements is shown below.

Most reactive	sodium
	calcium
	magnesium
	aluminium
	carbon
	zinc
	iron
	hydrogen
	lead
	copper
	silver
Least reactive	gold

Predict, giving a reason for your answer, whether the following pairs of substances react and give any expected observation(s).

(a) Iron and copper sulfate solution [2]

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(b) Magnesium and dilute hydrochloric acid [2]

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(c) Aluminium oxide and carbon [2]

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2. A student was investigating the reactivity of copper, magnesium and zinc. He placed each metal into the solutions shown in the table and recorded his observations.

Metal	Solution	Observations
magnesium	copper sulfate	a brown solid forms and the solution turns from blue to colourless
zinc	copper sulfate	a brown solid forms and the solution turns from blue to colourless
magnesium	zinc sulfate	the magnesium ribbon turns dark grey
copper	zinc sulfate	no reaction

(a) Use the information in the table to place the metals in order of reactivity. [1]

Most reactive .....

.....

Least reactive .....

(b) Name the products formed in the reaction between magnesium and copper sulfate solution. [2]

..... and .....

(c) Give the chemical formula for zinc sulfate. ..... [1]

(d) Lead can be extracted from its oxide using carbon in a furnace.

(i) Balance the following symbol equation for the reaction taking place. [1]

$$\square\ PbO + C \longrightarrow \square\ Pb + CO_2$$

(ii) Oxidation and reduction both take place in the above reaction. Name the substance being oxidised and give a reason for your choice. [2]

Substance being oxidised .....

Reason .....

.....

(iii) State why heating with carbon cannot be used to extract aluminium from its ore. [1]

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3. *(a)* Give the electronic structure of sodium, Na. [1]

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(b) Draw a diagram to show the metallic bonding in sodium. [2]

(c) (i) Sodium reacts vigorously with water.

Give **two** observations you would make when a small piece of sodium is added to a trough of water. [1]

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(ii) Name the products of this reaction. [1]

..... and .....

(d) As you go down Group 1 of the Periodic Table the elements become more reactive.

State the main difference you would see if potassium instead of sodium was added to water. [1]

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(e) Explain why Group 1 metal reactivity increases down the group. [2]

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4. *(a)* The table below shows some properties of three elements in the Periodic Table.

Element	Melting point (°C)	Boiling point (°C)	Appearance	Malleable or brittle?	Electrical conductivity
aluminium	660	2519	shiny solid	malleable	good
silicon	1414	3265	shiny solid	brittle	semiconductor
phosphorus	44	280	white solid	brittle	poor

Describe how the information in the table shows that silicon is difficult to classify as a metal or a non-metal. [2]

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(b) Give the **symbol** of the element which is found in Group 2 and Period 3 of the Periodic Table. [1]

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(c) (i) The chemical formula of copper(II) nitrate is $Cu(NO_3)_2$. Give the number of nitrogen atoms in the formula $Cu(NO_3)_2$. [1]

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(ii) Give the chemical formula of silver oxide. [1]

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(d) Nano-scale silver particles are added to socks to reduce the effects of smelly feet. Recent research has found that these particles can easily leak into waste water during washing.

(i) State the property of nano-scale silver particles that makes them useful in socks.

..... [1]

(ii) Suggest a reason why some scientists are concerned about nano-scale silver particles entering waste water. [1]

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5. Lithium, sodium and potassium are Group 1 metals.

(a) A teacher wanted to demonstrate the similarities and differences in how each metal reacted with water. She added a small piece of each metal separately to a trough of water.

Describe what you would see when each metal is added to water and state how the observations can be used to establish the trend in reactivity within the group. [6 QWC]

(b) The teacher then demonstrated the reaction of sodium with oxygen.

Complete and balance the symbol equation for this reaction. [2]

$$\square\ Na + O_2 \longrightarrow \square$$ .....

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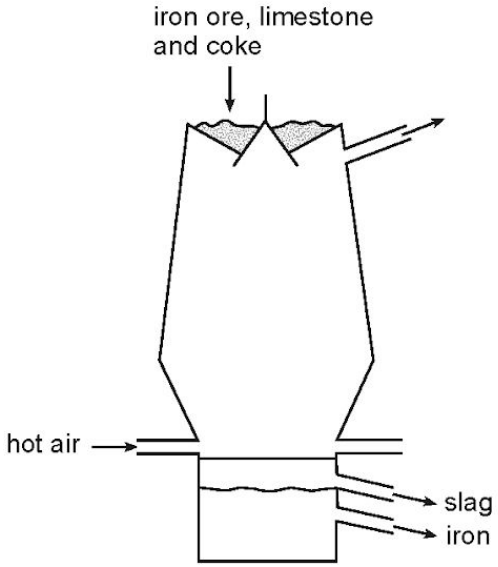
6. The diagram below shows the blast furnace which is used to extract iron.



Give a detailed description of the extraction of iron. [6 QWC]

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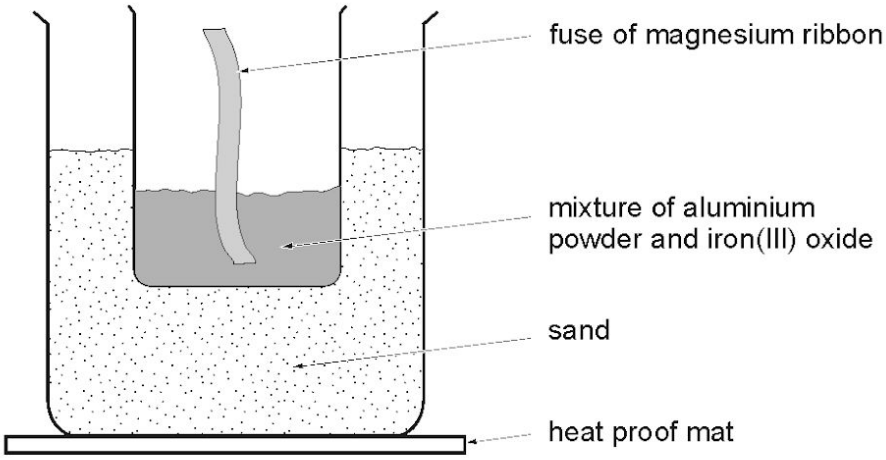
7. *(a)* When a mixture of iron(III) oxide and aluminium powder (thermite) is heated in the apparatus shown below, there is a violent reaction. There is a bright flame, sparks are produced and molten iron is formed.



(i) Write a **word** equation for the reaction taking place. [2]

..... + ... ⟶ ..... + ...

(ii) Explain this reaction in terms of reactivity. [2]

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(iii) State how the observations would be different if the mixture were replaced with a mixture of copper powder and aluminium oxide. [1]

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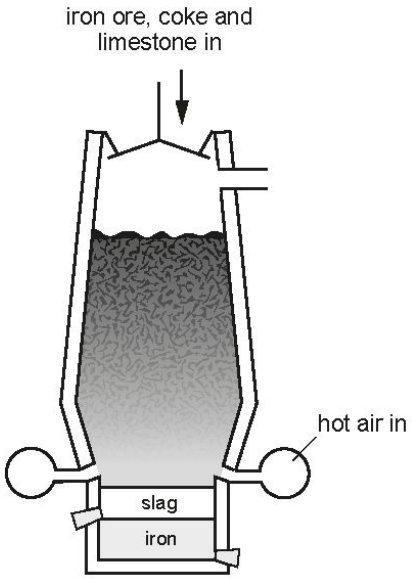
(b) Iron is extracted from its ore in a blast furnace.



(i) State the purpose of the following raw materials. [3]

Iron ore

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Coke

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Limestone

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(ii) The following equation shows the reaction taking place.

Fe_2O_3 + ☐ CO ⟶ ☐ Fe + ☐ CO_2

I. Balance the equation. [1]

II. Iron(III) oxide is reduced during the reaction. Give the meaning of *reduction*. [1]

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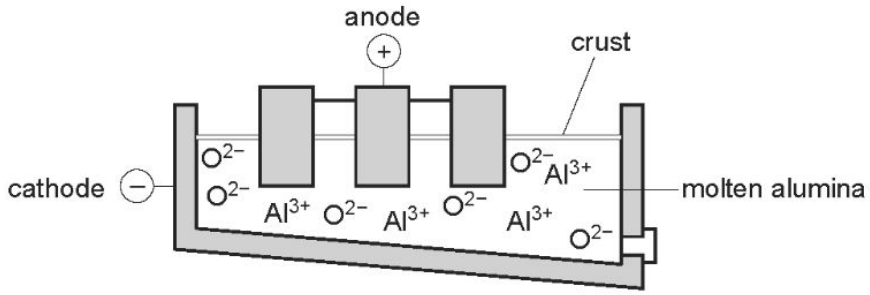
8. *(a)* Aluminium is obtained by the electrolysis of molten alumina.



The electrode equations below show how the products are formed.

$$Al^{3+} + 3e \longrightarrow Al$$

$$2O^{2-} - 4e \longrightarrow O_2$$

(i) Choose from the equations above

an ion, ...

an atom, ...

a molecule. ..... [2]

(ii) At which electrode is aluminium formed? Give the reason for your answer. [2]

.....

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(iii) Use the information in the diagram above to give the chemical name and formula of alumina. [2]

Chemical name .....

Formula .....

(iv) State **one** environmental problem associated with the **electrolysis** of molten alumina. [1]

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(b) Aluminium is a good electrical conductor and is therefore used to make overhead power cables.

Give a **different** property of aluminium and **one** use which relies on this property. [1]

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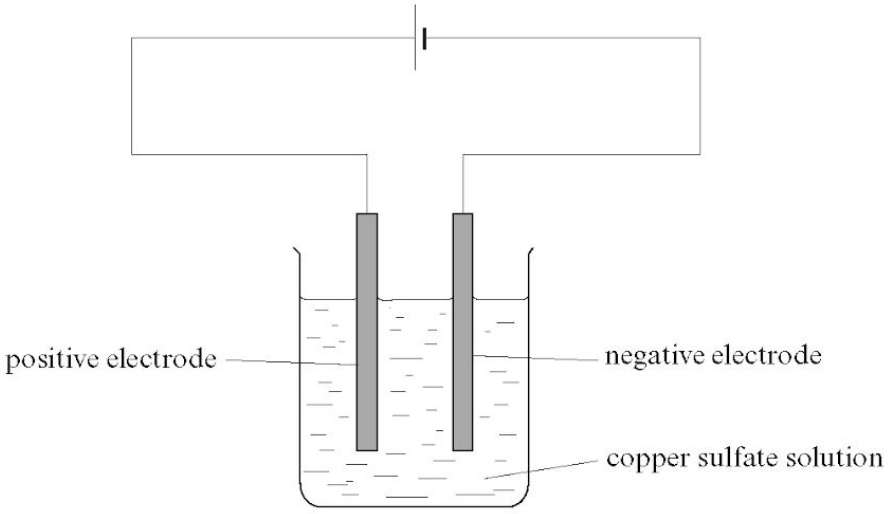
9. The electrolysis of copper sulfate solution was carried out using the apparatus shown in the diagram below. During the electrolysis, copper metal was deposited on the negative electrode.



(a) Identify the electrolyte. [1]

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(b) State the name given to a positive electrode. [1]

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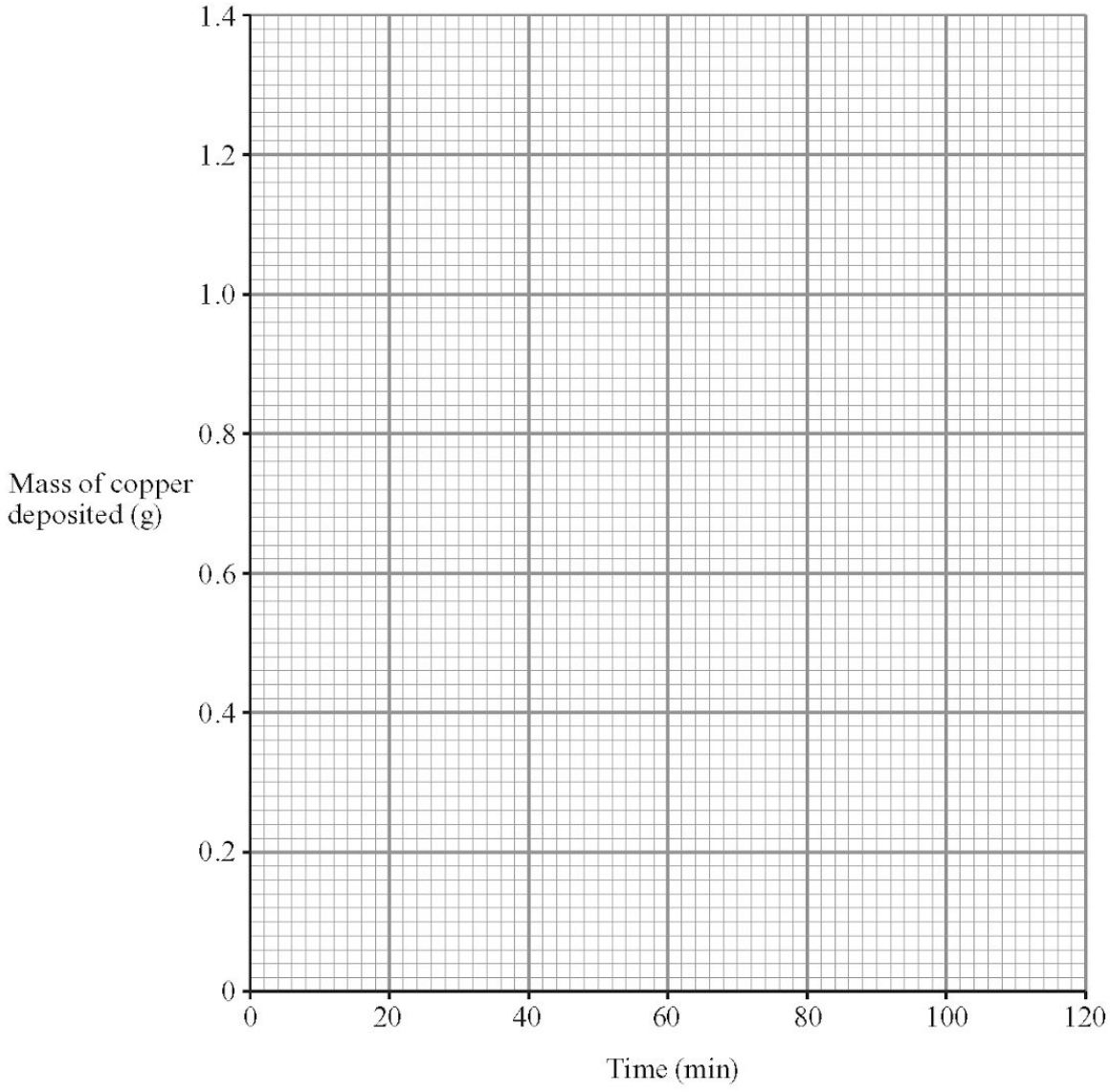
(c) The following results were obtained during the electrolysis of copper sulfate solution. The mass of the negative electrode was measured at intervals.

Initial mass of the negative electrode = 20.2 g

Time (min)	Mass of negative electrode and deposited copper (g)	Mass of copper deposited (g)
0	20.2	0.0
20	20.7	0.5
40	21.0	.....
60	21.2	1.0
90	21.4	1.2
120	21.4	1.2

(i) Complete the table opposite by calculating the mass of copper deposited after 40 minutes. [1]

(ii) Plot the data on the grid below and draw a suitable line. [3]



(iii) Use the graph to find the mass of copper deposited after 30 minutes. [1]

..... g

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10. *(a)* Aluminium can be extracted by the electrolysis of molten aluminium oxide.

(i) State what is added to aluminium oxide to reduce its melting point. [1]

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(ii) Aluminium metal is released at the cathode according to the following electrode equation.

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

Balance the electrode equation for the reaction that takes place at the anode. [1]

$$\square\ O^{2-} - \square\ e^- \longrightarrow O_2$$

(b) Lead can be produced by the electrolysis of molten lead(II) bromide, $PbBr_2$.

(i) Complete the balanced electrode equation for the reaction that takes place at the cathode. [2]

..... + ... $\longrightarrow$ Pb

(ii) Explain the formation of bromine during the electrolysis of molten lead(II) bromide. [3]

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11. *(a)* The box below contains some properties of aluminium.

low density	**resists corrosion**
good electrical conductor	**good thermal conductor**

Window frames can be made from several materials including aluminium and iron. Choose **one** property from the box which makes aluminium a **better** material than iron for making window frames. Give a reason for your answer. [2]

Property .....

Reason .....

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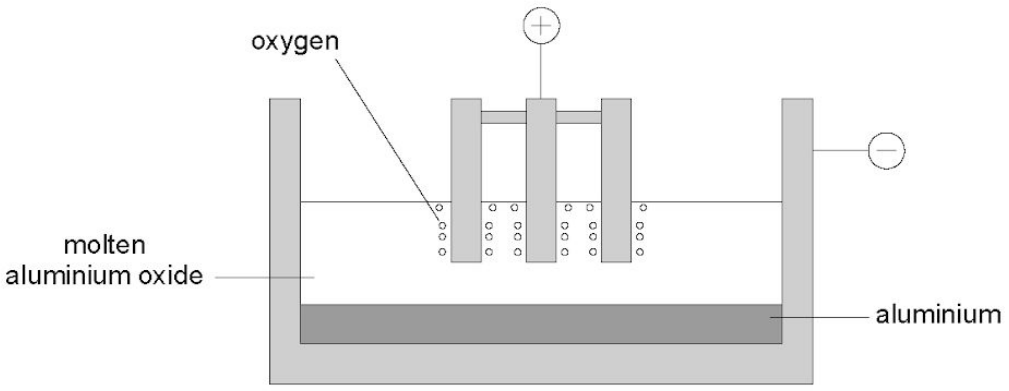
(b) The diagram below shows an electrolysis cell used in the extraction of aluminium.



(i) Which **negative ion** is attracted to the positive electrode? ..... [1]

(ii) Write a **word** equation for the overall reaction occurring. [1]

..... ⟶ ..... + ...

(iii) The temperature of the electrolysis cell is about 1000 °C. The melting point of aluminium is 660 °C.

Give the state (*solid*, *liquid* or *gas*) of the aluminium in the cell. [1]

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(iv) Give the **main** reason why this process is expensive. [1]

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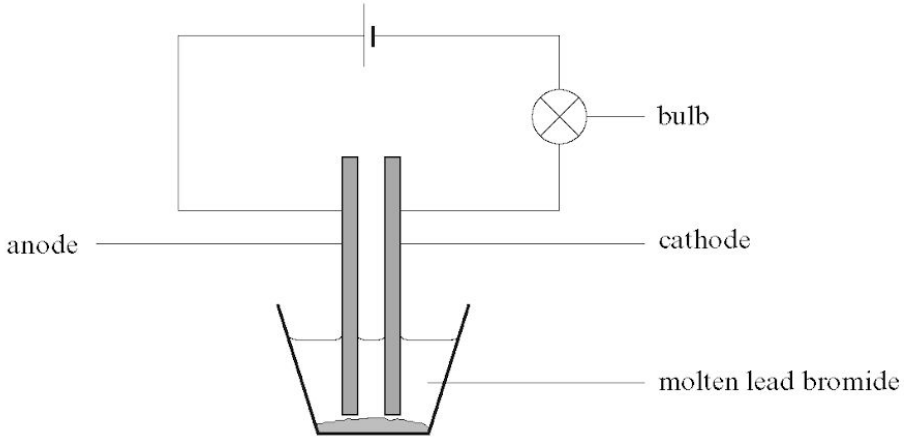
12. The diagram below shows the apparatus used during the electrolysis of molten lead bromide.



(a) For electricity to flow the lead bromide must be molten. Give the reason for this. [1]

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(b) Balance the electrode equation which takes place at the anode. [1]

$\square\ Br^- \rightarrow \square\ e^- + Br_2$

(c) (i) State, **in terms of electrons**, what happens to the lead ions at the cathode. [1]

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(ii) Describe what you would expect to observe at the cathode. [1]

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(iii) Electrolysis is allowed to continue for some time before the apparatus is cooled to room temperature. The bulb remains lit. Explain this observation. [2]

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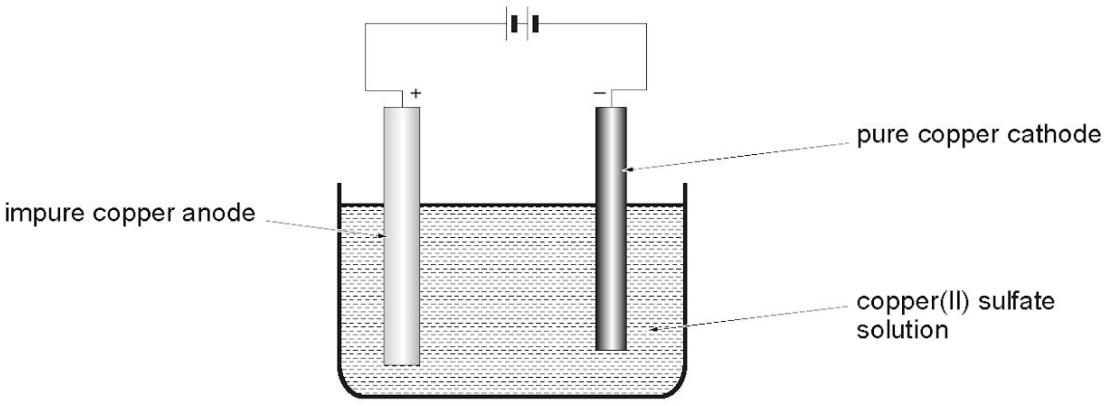
13. Copper can be purified by electrolysis using the apparatus shown below.



(a) During the process copper(II) ions move to the cathode where they become copper atoms.

(i) Explain why copper(II) ions move towards the cathode. [2]

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(ii) Complete and balance the following electrode equation that shows how copper forms at the cathode. [1]

..... + ☐ e^- ⟶ Cu

(b) A student carried out an investigation to find out how the amount of copper deposited on the cathode varied with the voltage used. He weighed the cathode at the beginning and then after 1 minute. He repeated the experiment 3 times at 5 different voltages. The results obtained are shown below.

Voltage (V)	Mass of copper deposited after 1 minute (g)			
	1	2	3	Mean
1.0	0.12	0.13	0.11	0.12
2.0	0.13	0.13	0.14	0.13
3.0	0.16	0.10	0.16	0.16
4.0	0.18	0.18	0.17	0.18
5.0	0.19	0.21	0.29	.....

(i) Using only the reliable results, calculate the mean mass of copper deposited on the cathode at 5.0 V. [1]

Mean mass of copper deposited = ... g

(ii) Calculate the percentage error of the unreliable result at 5.0 V. [1]

$$\text{Percentage error} = \frac{\text{difference between result and mean}}{\text{mean result}} \times 100\,\%$$

Percentage error = ... %

(iii) Use the results to predict the mass of copper deposited after 1 minute when a voltage of 8.0 V is applied. Give a reason for your answer. [2]

Mass deposited ..... g

Reason .....

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14. Copper and titanium are important metals. The following table shows some of their uses.

Metal	Uses
copper	electrical wiring, water pipes, saucepan bases, jewellery
titanium	hip replacements, rotors on helicopters, pipes in chemical industry

Describe how the properties of copper and titanium make them suitable for these uses.

[6 QWC]

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15. Copper and titanium are important metals. The following table shows some of their uses.

Metal	Uses
copper	electrical wiring, water pipes, saucepan bases, jewellery
titanium	hip replacements, rotors on helicopters, pipes in chemical industry

Describe how the properties of copper and titanium make them suitable for these uses.
[6 QWC]

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16. Describe the properties of metals and relate these properties to the uses of two metals of your choice. [6 QWC]

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