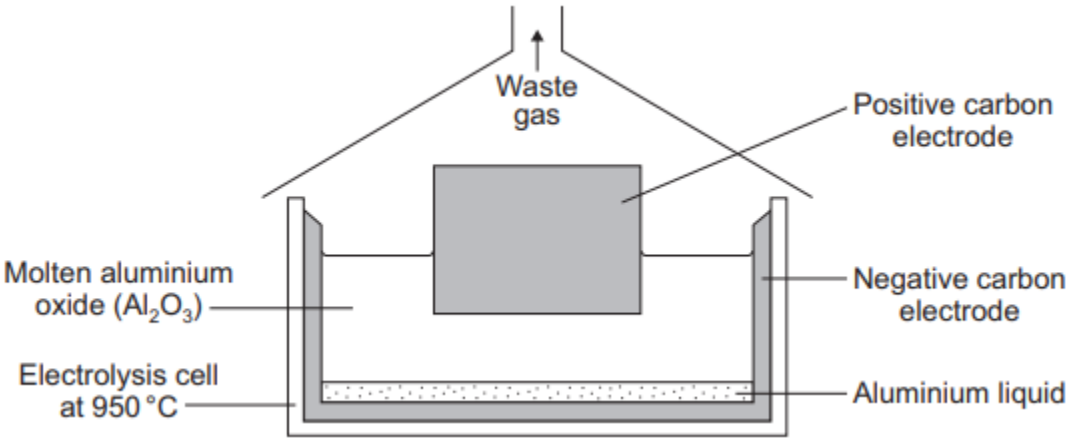
REDOX REACTIONA & ELECTROLYSIS 3

Q1. Aluminium is used for drinks cans.

Aluminium is extracted from its purified ore by electrolysis.



(i) Suggest why the aluminium produced in the electrolysis cell is a liquid.

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(1 mark)

(ii) In this electrolysis, aluminium and oxygen gas are produced from the aluminium oxide.

Use the information in the diagram to suggest why most of the waste gas is carbon dioxide and not oxygen.

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_____

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_____

(2 marks)

Q2. Titanium is used for replacement hip joints because it has a low density, is strong and does not corrode. Titanium is extracted from titanium dioxide (TiO_2) in three stages.

Stage 1

Titanium dioxide is converted into titanium chloride ($TiCl_4$) because the metal cannot be extracted from its oxide by reduction with carbon.

(i) What does reduction mean?

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_____

(1 mark)

Stage 2

(ii) Titanium is extracted from the titanium chloride by reacting it with sodium at 1000 °C in a reactor.

The only other substance in the reactor is argon gas.

$$TiCl_4 + 4Na \rightarrow Ti + 4NaCl$$

What does this tell you about the reactivity of sodium compared with titanium?

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_____

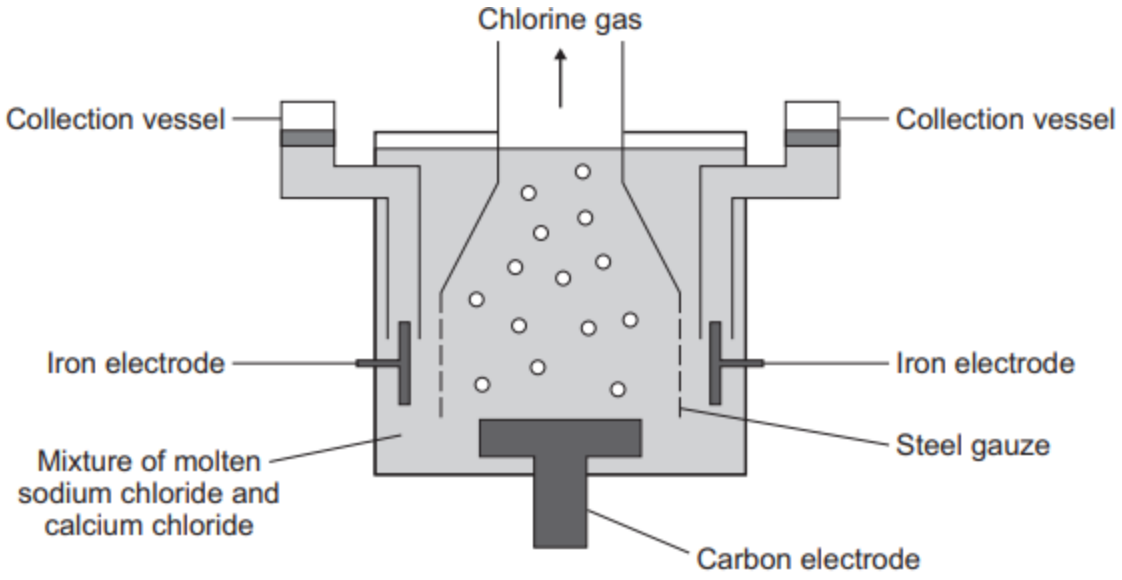
(1 mark)

Q3. Sodium cannot be extracted from its oxide by reduction with carbon.

Sodium metal is extracted by electrolysis of molten sodium chloride. The melting point of sodium chloride is very high (800°C), so calcium chloride is added to reduce the melting point of the mixture to about 550°C.

During electrolysis, both sodium and calcium are obtained at the iron electrodes, and chlorine at the carbon electrode.

The diagram shows the electrolysis cell used for the extraction of sodium.



The table shows some properties of sodium and calcium.

	Melting point in °C	Density in g per cm^3	Reactivity
Sodium	97	0.97	Very reactive
Calcium	839	1.55	Reactive

(a) In the extraction of sodium, a mixture of sodium chloride and calcium chloride is used to

1 reduce the amount of energy required to melt the mixture.

2 obtain a pure sample of sodium.

3 absorb the chlorine gas.

4 increase the temperature of the mixture.

(b) The purpose of the steel gauze is to prevent the reaction of . . .

1 sodium with calcium.

2 sodium with chlorine.

3 iron electrodes with sodium chloride.

4 sodium chloride with calcium chloride.

(c) In the collection vessel there is . . .

1 solid sodium below a layer of liquid calcium.

2 solid calcium below a layer of liquid sodium.

3 a mixture of liquid sodium and liquid calcium.

4 a mixture of solid calcium and solid sodium.

(d) The information in the diagram suggests that the element carbon . . .

1 has a melting point lower than 550°C.

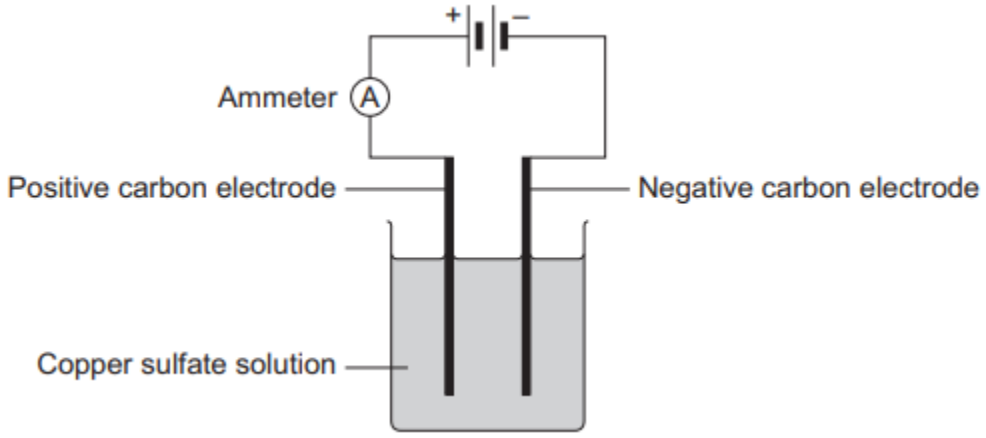
2 reacts rapidly with chlorine gas.

3 is an electrical conductor.

4 is more reactive than iron.

(4 marks)

Q4. A student investigated the extraction of copper from copper sulfate solution using electrolysis. The apparatus used is shown in the diagram.



The results are shown in the table.

Current in amps	Time in seconds	Quantity of electricity in coulombs	Mass of copper deposited on the negative electrode in grams
0.5	600	300	0.12
1.0	600	600	0.24
1.5	600	900	0.36
2.0	600	1200	0.48
2.5	600	1500	0.66
3.0	600	1800	0.72

(a) The results are best displayed as a . . .

1 bar chart.

2 scattergram.

3 pie chart.

4 line graph.

(1 mark)

(b) The mass of copper deposited on the negative electrode for each current was higher than expected. This is probably because . . .

1 the copper was very pure.

2 the student did not dry the electrode before weighing it.

3 the copper sulfate solution was too dilute.

4 copper quickly evaporates at room temperature.

(1 mark)

(c) There is an anomalous result for a current of . . .

1 1.0 amps.

2 2.0 amps.

3 2.5 amps.

4 3.0 amps.

(1 mark)

(d) The pattern in the results indicates that . . .

1 when the quantity of electricity doubles, the mass of copper deposited doubles.

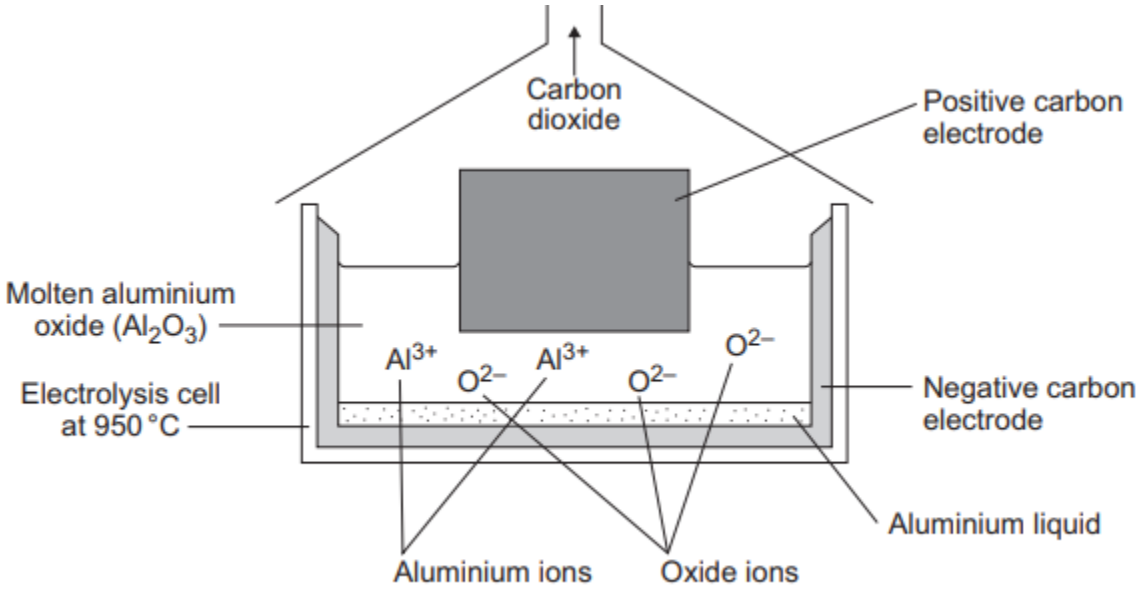
2 the mass of copper deposited does not depend on the time.

3 the mass of copper deposited does not depend on the current used.

4 when the current doubles, the mass of copper deposited halves.

(1 mark)

Q5. Aluminium can be produced by electrolysis.



Why do the aluminium ions collect at the negative electrode?

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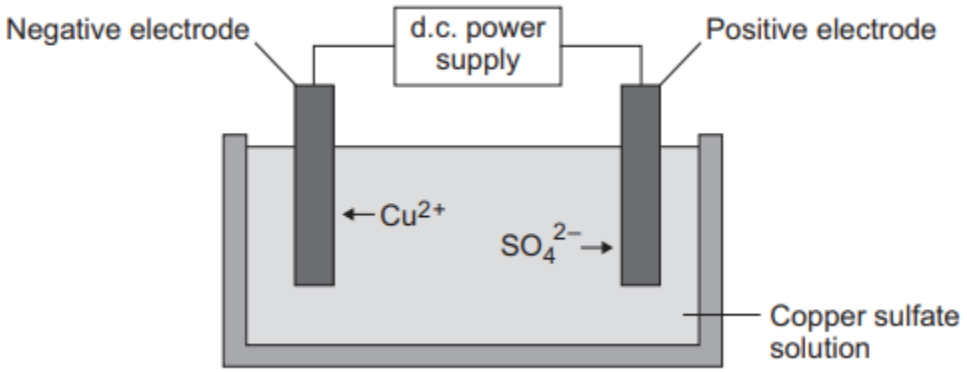
(2 marks)

Q6. The figure below shows the electrolysis of copper sulfate solution.



Describe what happens to the copper ions during electrolysis.

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(2 marks)

Total marks (17)