AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.1.3

Extraction of metals and reduction

Past-paper questions

Tier	**Foundation**
Question groups	**7**
Available paper years	**2019–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

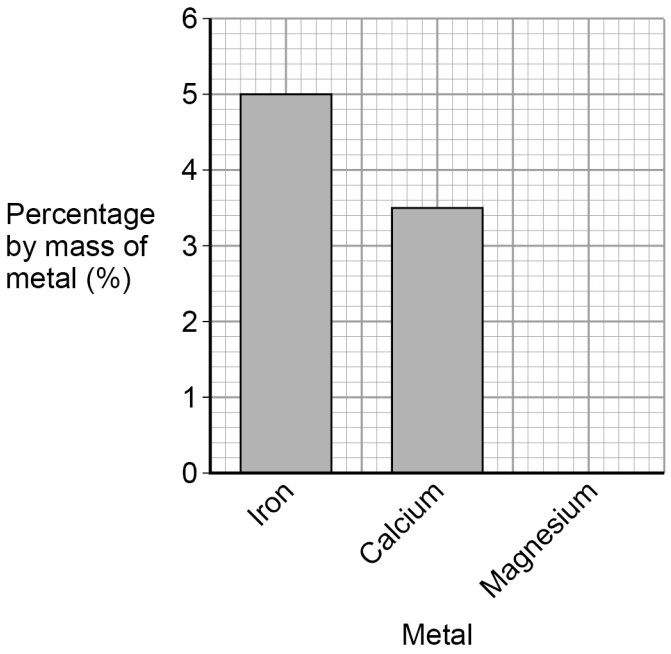
5.4.1.3 Extraction of metals and reduction

Question 01

June 2019 | 8464/C/2F | Original Q5

0 5 **Figure 6** shows the percentage by mass of some metals in the Earth's crust.

Figure 6



0 5 . 1 What is the percentage by mass of calcium in the Earth's crust?

[1 mark]

Tick (✓) **one** box.

3.25% ☐ 3.50% ☐ 4.50% ☐ 5.00% ☐

0 5 . 2 The percentage by mass of magnesium in the Earth's crust is 2.1%

Draw the bar for magnesium on **Figure 6**.

[1 mark]

Question 5 continues on the next page

5.4.1.3 Extraction of metals and reduction

Question 01 · continued

0 5 . 3 Copper sulfate is produced during the extraction of copper from the Earth's crust.

Copper is produced from copper sulfate solution using iron.

The word equation for the reaction is:

copper sulfate + iron → iron sulfate + copper

From the equation a company calculated that 648 kg of copper sulfate are needed to produce 617 kg of iron sulfate and 258 kg of copper.

Calculate the mass of iron needed to make 258 kg of copper.

[2 marks]

Mass = _____ kg

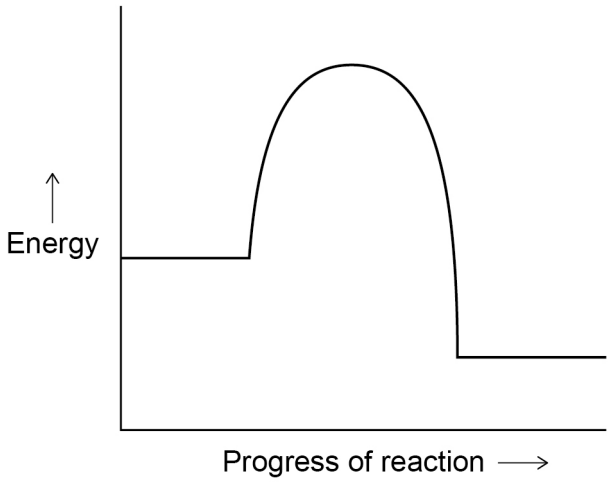
5.4.1.3 Extraction of metals and reduction

Question 01 · continued

Copper is used as a catalyst.

0 5 . 4 **Figure 7** shows the reaction profile for a reaction without a catalyst.

Figure 7

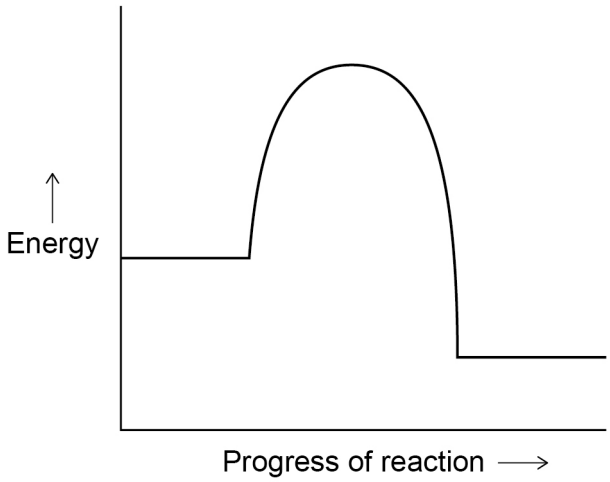


Draw an arrow on **Figure 7** to show the activation energy.

[1 mark]

0 5 . 5 The reaction profile for the reaction without a catalyst is shown again in **Figure 8.**

Figure 8



Draw a reaction profile on **Figure 8** for the same reaction with a catalyst.

[2 marks]

5.4.1.3 Extraction of metals and reduction

Question 01 · continued

0 5 . 6 What are catalysts in biological systems called?

[1 mark]

Tick (✓) **one** box.

- Detergents ☐
- Enzymes ☐
- Polymers ☐
- Solvents ☐

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5.4.1.3 Extraction of metals and reduction

Question 02

November 2020 | 8464/C/1F | Original Q6

0 6 This question is about the extraction of aluminium.

0 6 . 1 An aluminium atom is represented as:

$$^{27}_{13}Al$$

Give the number of electrons and neutrons in the aluminium atom.

[2 marks]

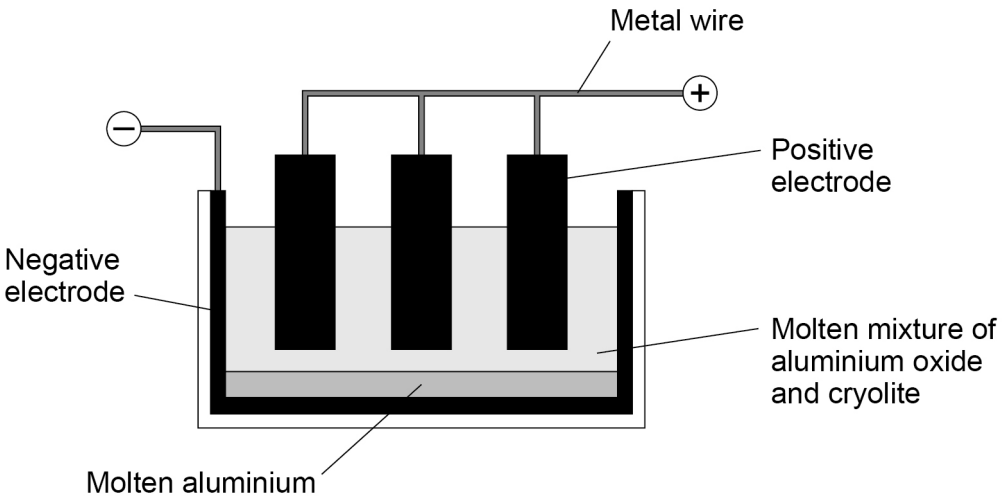
Number of electrons _____

Number of neutrons _____

Aluminium is extracted by the electrolysis of a molten mixture of aluminium oxide and cryolite.

Figure 11 shows the cell used for the electrolysis.

Figure 11



0 6 . 2 Aluminium is produced by the reduction of aluminium oxide (Al_2O_3).

What is meant by the term reduction?

[1 mark]

_____

_____

5.4.1.3 Extraction of metals and reduction

Question 02 · continued November 2020 | 8464/C/1F | Original Q6

0 6 . 3 Oxygen is formed at the positive carbon electrodes.

Explain why the positive carbon electrodes must be continually replaced.

[3 marks]

0 6 . 4 A substance conducts electricity because of free moving, charged particles.

What are the free moving, charged particles in a:

- carbon electrode (made from graphite)
- molten mixture of aluminium oxide and cryolite
- metal wire?

[3 marks]

Carbon electrode (made from graphite) _____

Molten mixture of aluminium oxide and cryolite _____

Metal wire _____

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5.4.1.3 Extraction of metals and reduction

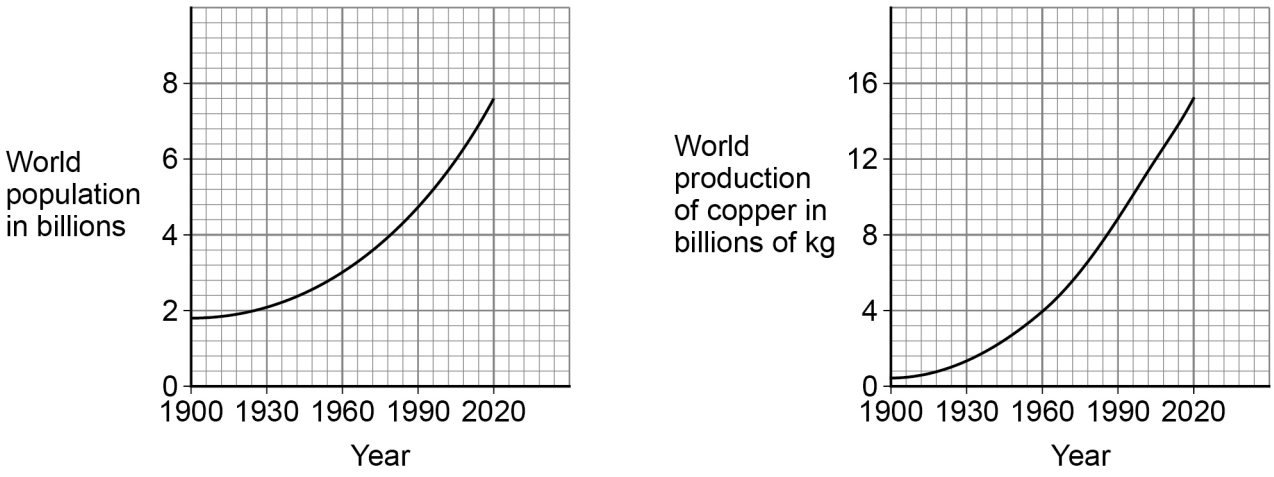
Question 03

November 2021 | 8464/C/2F | Original Q5

0 5 Industries use the Earth's resources to produce useful products.

0 5 . 1 **Figure 4** shows the world population and the world production of copper between 1900 and 2020.

Figure 4



How does the change in the world population compare with the world production of copper?

[1 mark]

Tick (✓) **one** box.

As population decreased, copper production increased. ☐

As population increased, copper production decreased. ☐

As population increased, copper production increased. ☐

5.4.1.3 Extraction of metals and reduction

Question 03 · continued

Copper is produced from copper ore and from recycling waste copper.

0 5 . 2 The energy needed to produce 1 kg of copper from copper ore is 70 MJ.

The energy needed to produce 1 kg of recycled copper is 27 MJ.

Calculate the energy saved if 100 kg of copper is produced from recycled copper and **not** from copper ore.

[3 marks]

Energy saved = _____ MJ

0 5 . 3 Producing copper from recycling waste copper reduces emissions of sulfur dioxide.

Why is reducing emissions of sulfur dioxide important?

[1 mark]

0 5 . 4 Copper is used to make coins.

A coin of mass 8 g contains 75% copper.

Calculate the mass of copper in the coin.

[2 marks]

Mass of copper = _____ g

5.4.1.3 Extraction of metals and reduction

Question 03 · continued

0 5 . 5 Iron and glass are both produced from the Earth's resources.

Some processes can reduce the use of limited resources.

Draw **one** line from the description of the process to the name of the process.

[2 marks]

Description of process	Name of process
	Extraction
Scrap steel is added to iron from a blast furnace	Quarrying
	Reacting
A glass bottle is refilled	Recycling
	Reusing

5.4.1.3 Extraction of metals and reduction

Question 03 · continued

0 5 . 6 Life cycle assessments are used to assess the environmental impact of producing iron nails and glass bottles.

There are four stages, **A**, **B**, **C** and **D**, in a life cycle assessment.

The stages are **not** in the correct order.

Stage **A** Disposal

Stage **B** Extracting and processing raw materials

Stage **C** Manufacturing and packaging

Stage **D** Use and operation

What is the correct order of stages **A**, **B**, **C**, and **D**?

[1 mark]

Tick (✓) **one** box.

C, **D**, **B**, **A** ☐

D, **B**, **C**, **A** ☐

B, **C**, **D**, **A** ☐

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5.4.1.3 Extraction of metals and reduction

Question 04

June 2022 | 8464/C/1F | Original Q4

0 4 This question is about elements and compounds.

0 4 . 1 Magnesium and oxygen react to produce magnesium oxide.

Balance the equation for the reaction.

[1 mark]

$$_____ Mg + O_2 \rightarrow 2\,MgO$$

0 4 . 2 Suggest **one** safety precaution that should be taken when heating magnesium and oxygen.

[1 mark]

0 4 . 3 Calculate the relative formula mass (M_r) of magnesium fluoride (MgF_2).

Relative atomic masses (A_r): F = 19 Mg = 24

[2 marks]

Relative formula mass (M_r) = _____

0 4 . 4 Argon is a noble gas.

Explain why **no** product is formed when magnesium and argon are heated together.

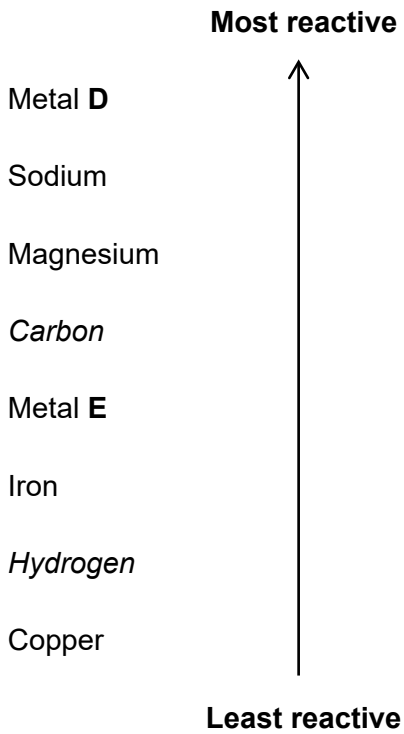
[2 marks]

5.4.1.3 Extraction of metals and reduction

Question 04 · continued

0 4 . 5 **Figure 10** shows a reactivity series.

Figure 10



Question 04 · continued

Draw **one** line from each metal to the method used to extract that metal.

Use **Figure 10**.

[2 marks]

Metal	**Method used to extract that metal**
	Extracted by electrolysis of a molten ionic compound.
Metal **D**	Extracted from its oxide by reduction with carbon.
	Extracted from its oxide by reduction with hydrogen.
Metal **E**	
	Removed from the Earth as the metal itself.

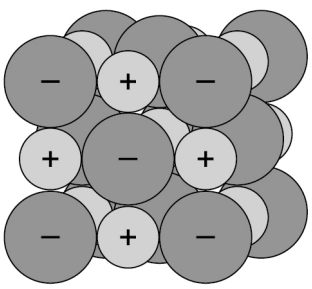
Question 4 continues on the next page

Question 04 · continued

A substance conducts electricity when it has charged particles that are free to move.

0 4 . 6 **Figure 11** represents the structure of sodium chloride.

Figure 11



Sodium chloride

Explain why sodium chloride conducts electricity when molten but **not** when solid.

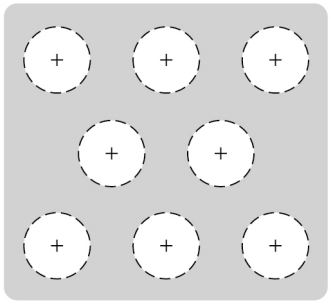
[3 marks]

5.4.1.3 Extraction of metals and reduction

Question 04 · continued

0 4 . 7 **Figure 12** represents the structure of sodium metal.

Figure 12



Sodium metal

Explain why sodium metal conducts electricity when solid.

[2 marks]

13

5.4.1.3 Extraction of metals and reduction

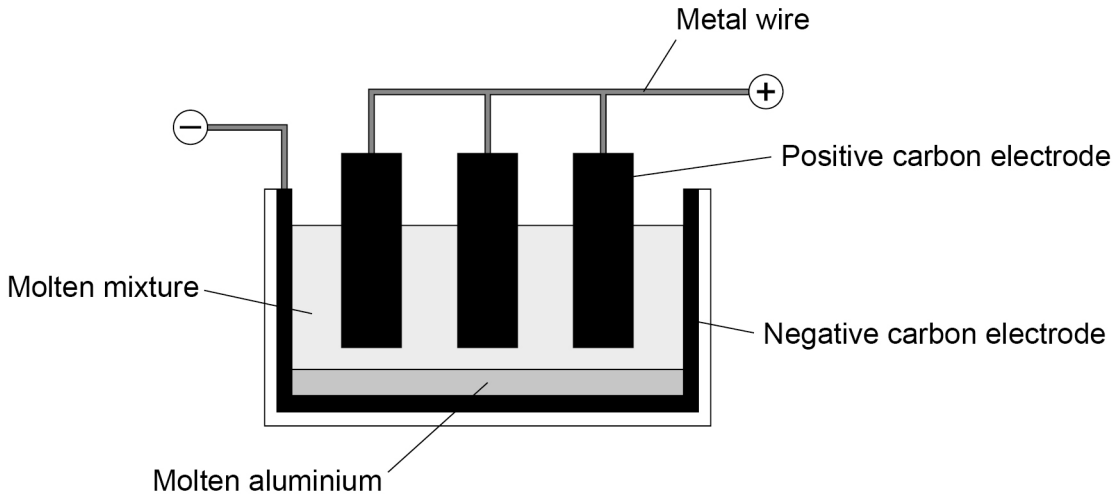
Question 05

0 5 This question is about extraction of metals.

Aluminium is extracted from a molten mixture of aluminium oxide and cryolite using electrolysis.

Figure 12 shows the electrolysis cell.

Figure 12



0 5 . 1 Complete the sentence.

[1 mark]

The extraction of aluminium is expensive because the process uses large amounts of _____ .

0 5 . 2 Oxygen is produced at the positive carbon electrodes.

The oxygen reacts with the carbon electrodes.

Which gas is produced when oxygen reacts with the positive carbon electrodes?

[1 mark]

_____

5.4.1.3 Extraction of metals and reduction

Question 05 · continued

Titanium is extracted from titanium chloride by reacting titanium chloride with sodium.

The reaction between titanium chloride and sodium is carried out in an inert atmosphere.

0 5 . 3 Suggest why the reaction is carried out in an inert atmosphere.

[1 mark]

0 5 . 4 Complete the sentence.

Choose the answer from the box.

[1 mark]

argon	**chlorine**	**hydrogen**

The gas used for the inert atmosphere is _____ .

0 5 . 5 Balance the equation for the reaction.

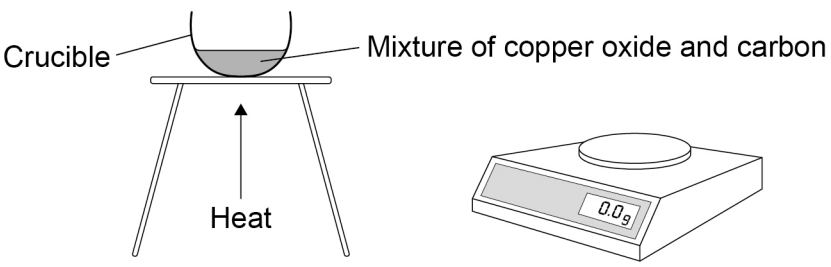
[1 mark]

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

Copper is extracted from copper oxide by reacting copper oxide with carbon.

Figure 13 shows the apparatus.

Figure 13



The equation for the reaction is:

$$2\,CuO(s) + C(s) \rightarrow 2\,Cu(s) + CO_2(g)$$

In an experiment 15.9 g of copper oxide and 1.2 g of carbon reacted.

12.7 g of copper was produced in the reaction.

0 5 . 6 Calculate the mass of carbon dioxide produced in this experiment.

[1 mark]

Mass of carbon dioxide = _____ g

0 5 . 7 Explain why the mass of the contents in the crucible changed during the experiment.

[2 marks]

5.4.1.3 Extraction of metals and reduction

Question 05 · continued

0 5 . 8 What happens to copper oxide in the reaction?

Give **one** reason for your answer.

Use the equation for the reaction.

[2 marks]

Tick (✓) **one** box.

The copper oxide is dissolved ☐

The copper oxide is oxidised ☐

The copper oxide is reduced ☐

Reason _____

_____

10

Turn over for the next question

5.4.1.3 Extraction of metals and reduction

Question 06

0 2 The Earth's atmosphere is always changing.

0 2 . 1 Gases in the Earth's early atmosphere caused changes on the Earth.

Draw **one** line from each change to the gas that caused the change.

[2 marks]

Change	Gas that caused the change
Oceans formed	Ammonia
Sedimentary rocks formed	Carbon dioxide
	Nitrogen
	Oxygen
	Water vapour

Question 06 · continued

Table 1 shows the percentage of some gases in the atmospheres of Earth and Mars today.

Table 1

Gas	Percentage of gas in atmosphere (%)	
	Earth	Mars
Argon	0.90	1.9
Carbon dioxide	0.04	95
Nitrogen	78	2.6
Oxygen	21	0.20

0 2 . 2 Which gas has the highest percentage in the Earth's atmosphere?

[1 mark]

0 2 . 3 Calculate how many times more carbon dioxide there is in the atmosphere of Mars than in the atmosphere of Earth.

Use **Table 1**.

Give your answer in standard form.

[3 marks]

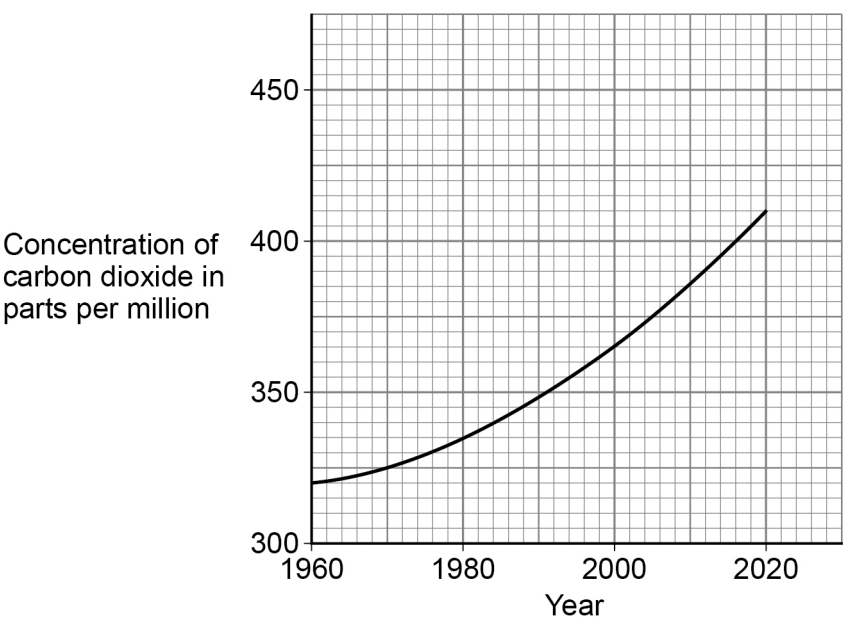
Number of times more carbon dioxide (in standard form) = _____

Question 06 · continued

Carbon dioxide is a greenhouse gas.

0 2 . 4 **Figure 1** shows the concentration of carbon dioxide in the Earth's atmosphere from 1960 to 2020.

Figure 1



How has the concentration of carbon dioxide in the Earth's atmosphere changed from 1960 to 2020?

[1 mark]

Tick (✓) **one** box.

Decreased ☐

Stayed the same ☐

Increased ☐

Question 06 · continued

0 2 . 5 Cars emit carbon dioxide.

A car emits 17.2 kg of carbon dioxide on a journey.

There are four people in the car.

Calculate the mass of carbon dioxide emitted per person.

[2 marks]

Mass of carbon dioxide = _____ kg

0 2 . 6 Planting trees helps to reduce climate change, because trees use carbon dioxide from the Earth's atmosphere.

Name the process in trees which uses carbon dioxide.

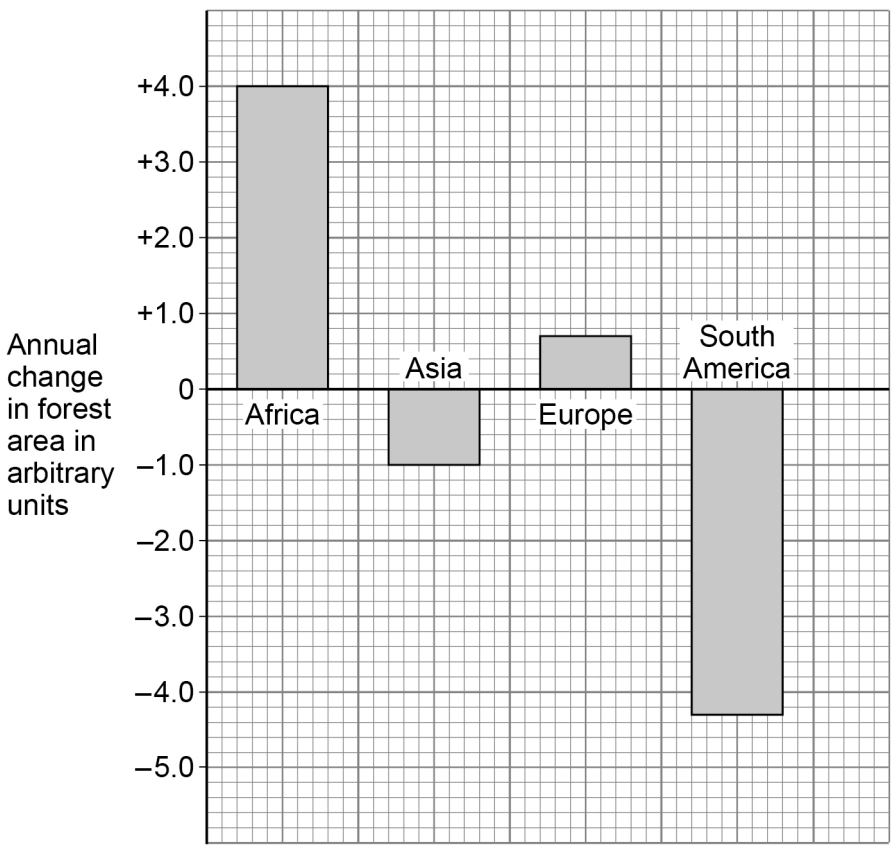
[1 mark]

Question 2 continues on the next page

Question 06 · continued

0 2 . 7 **Figure 2** shows the annual change in forest area in four different parts of the world.

Figure 2



Give **two** conclusions about the annual change in forest area.

[2 marks]

1 _____

_____

2 _____

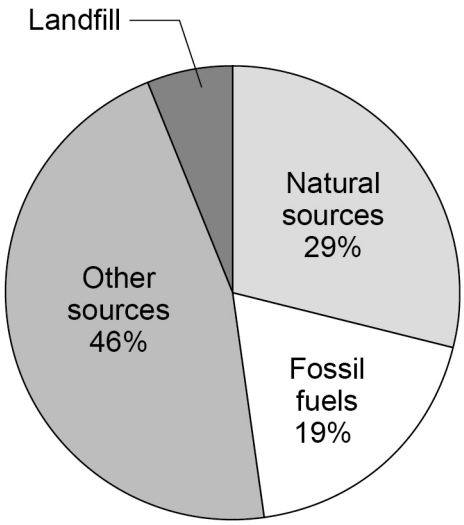
_____

Question 06 · continued

0 2 . 8 Methane is a greenhouse gas.

Figure 3 shows sources of methane emissions.

Figure 3



Determine the percentage (%) of methane emissions from landfill.

[1 mark]

Percentage = _____ %

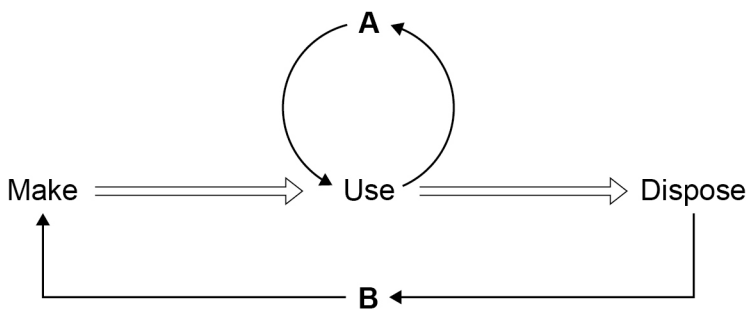
Question 2 continues on the next page

5.4.1.3 Extraction of metals and reduction

Question 06 · continued

0 2 . 9 **Figure 4** shows two ways (**A** and **B**) of preventing used items going to landfill.

Figure 4



Name **A** and **B**.

Choose answers from the box.

[2 marks]

recycle	**reduce**	**release**	**reuse**	**reverse**

A _____

B _____

15

5.4.1.3 Extraction of metals and reduction

Question 07

June 2025 | 8464/C/1F | Original Q4

0 4 This question is about metals.

0 4 . 1 Complete the sentence.

Choose the answer from the box.

[1 mark]

compounds	**elements**	**polymers**

Most metals are found in the Earth as _____.

0 4 . 2 Iron is extracted from iron oxide by reduction with carbon.

Why is iron extracted by reduction with carbon?

[1 mark]

Tick (✓) **one** box.

Iron is less reactive than carbon. ☐

Iron has the same reactivity as carbon. ☐

Iron is more reactive than carbon. ☐

Question 4 continues on the next page

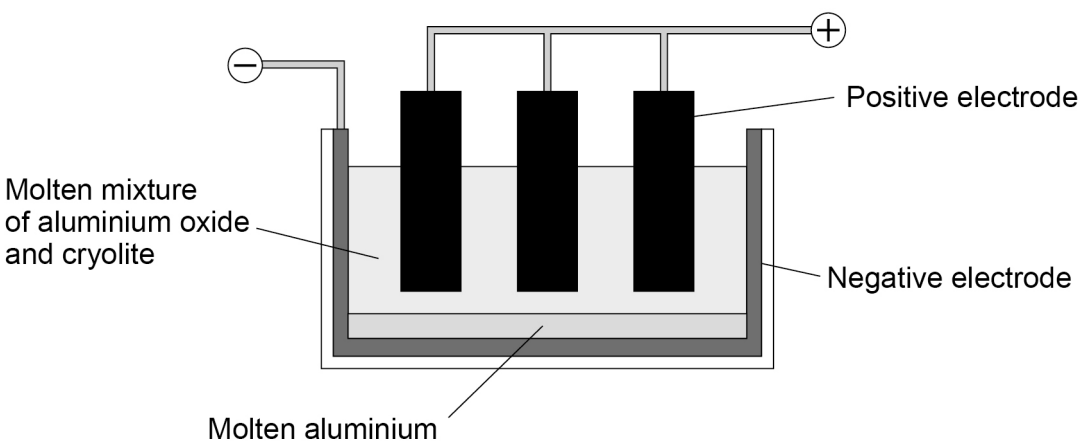
5.4.1.3 Extraction of metals and reduction

Question 07 · continued

Aluminium is extracted by the electrolysis of aluminium oxide.

Figure 8 shows the apparatus used to extract aluminium.

Figure 8



0 4 . 3 The mixture of aluminium oxide and cryolite has a lower melting point than aluminium oxide alone.

Why is the melting point lowered?

[1 mark]

Tick (✓) **one** box.

To reduce the amount of energy used ☐

To reduce the purity of the aluminium formed ☐

To reduce the rate of reaction ☐

5.4.1.3 Extraction of metals and reduction

Question 07 · continued

0 4 . 4 After some time, the positive electrodes need to be replaced.

Why must the positive electrodes be replaced?

[1 mark]

Tick (✓) **one** box.

- The electrodes dissolve in the molten mixture. ☐
- The electrodes melt in the molten mixture. ☐
- The electrodes react with aluminium. ☐
- The electrodes react with oxygen gas. ☐

Question 4 continues on the next page

5.4.1.3 Extraction of metals and reduction

Question 07 · continued

Aluminium can be mixed with other metals to form alloys.

0 4 . 5 How does the hardness of an alloy of aluminium compare with the hardness of pure aluminium?

[1 mark]

Tick (✓) **one** box.

The alloy is harder than the pure metal. ☐

The alloy and the pure metal have the same hardness. ☐

The alloy is less hard than the pure metal. ☐

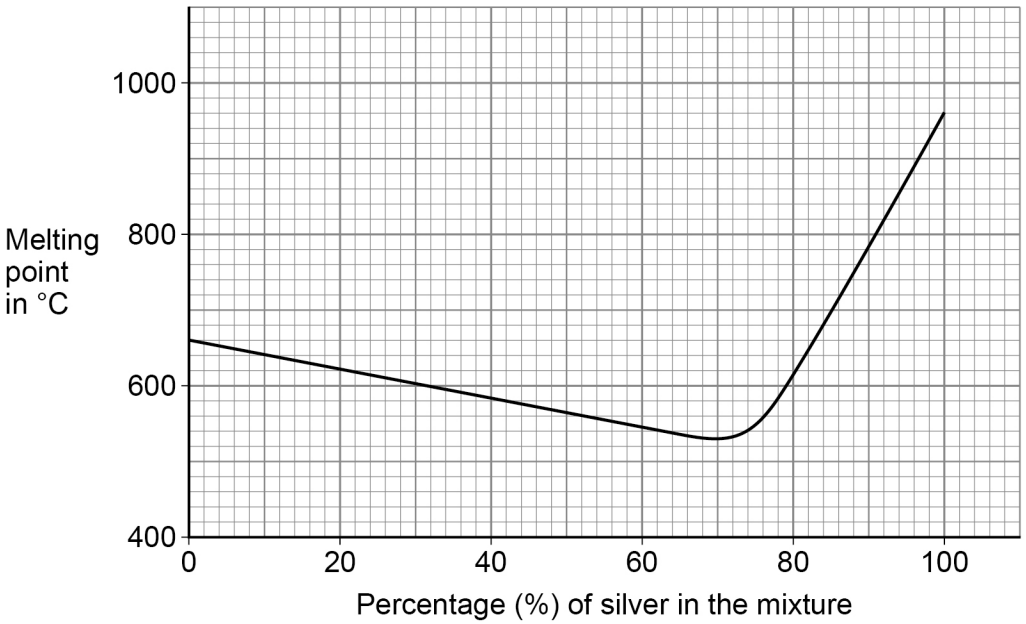
5.4.1.3 Extraction of metals and reduction

Question 07 · continued

0 4 . 6 Aluminium can form an alloy with silver.

Figure 9 shows how the melting point of the alloy changes with the percentage (%) of silver in the mixture.

Figure 9



Describe how the melting point of the alloy changes as the percentage of silver in the mixture increases.

Use data from **Figure 9**.

[3 marks]

8