AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.1.3

Extraction of metals and reduction

Past-paper questions

Tier	**Foundation**
Question groups	**52**
Available paper years	**2007–2025**

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.

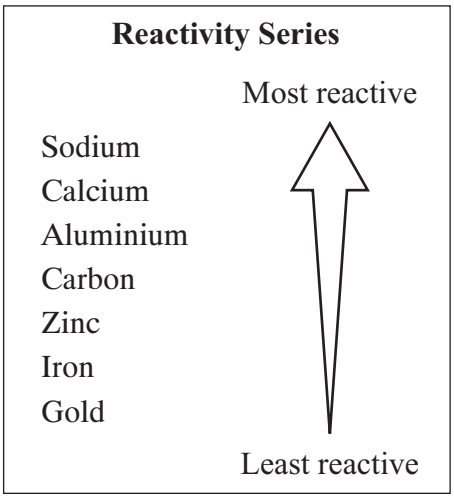
4.4.1.3 Extraction of metals and reduction

Question 01

March 2007 | CHY1A | Original Q5 | Legacy

QUESTION FIVE

This question is about metals.



Match metals, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A aluminium

B calcium

C sodium

D zinc

	What we can say about the metal
1	It has the symbol Na
2	Its oxide is called quicklime.
3	It is more reactive than iron but can be extracted from its oxide by heating with carbon.
4	It is less reactive than calcium but cannot be extracted from its oxide by reduction with carbon.

4.4.1.3 Extraction of metals and reduction

Question 02

June 2007 | CHY1A | Original Q6 | Legacy

QUESTION SIX

This question is about iron and steel.

Match properties, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A hard

B resistant to corrosion

C easily shaped

D brittle

Iron from the blast furnace has few uses because it is . . . **1** . . . .

A low carbon steel is used to make wire because it is . . . **2** . . . .

A high carbon steel is used to make hammers and chisels because it is . . . **3** . . . .

A stainless steel is used to make cutlery because it is . . . **4** . . . .

4.4.1.3 Extraction of metals and reduction

Question 03

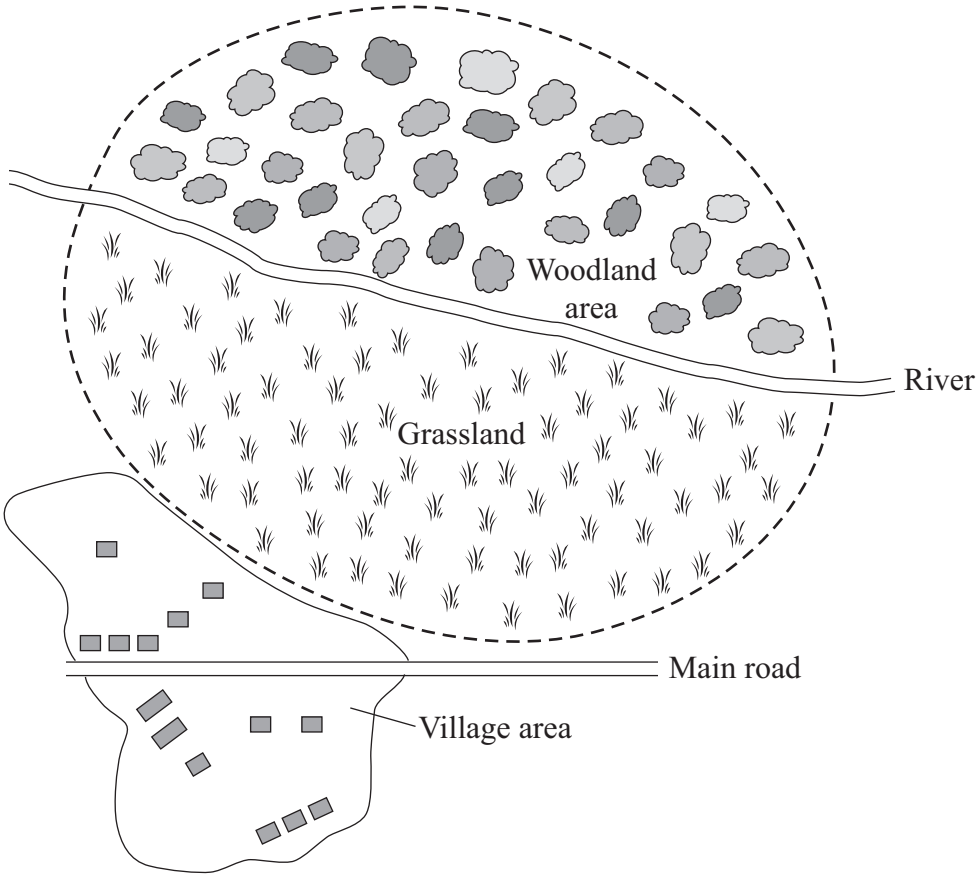
June 2007 | CHY1F | Original Q4 | Legacy

4 Iron ore is the main source of iron.

(a) This was the headline in a newspaper.

‘Village protests against quarry’

The dotted line (- - - -) on the map is drawn around the area from which a company wants to quarry iron ore.



(i) Give **one** reason that the company could give for the need to quarry the iron ore.

.....

.....

(1 mark)

Question 03 · continued

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(ii) The people who live in the village do not want the quarry because it would decrease the value of their homes.

Suggest **two** other reasons why the villagers do not want the quarry.

1 .....

.....

2 .....

.....

(2 marks)

(b) Iron ore contains the compound iron oxide, Fe_2O_3.

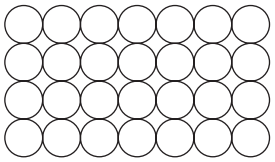
(i) Iron is extracted from its oxide in the blast furnace.

Complete the word equation for the extraction of iron.

iron oxide + ... → iron + carbon dioxide

(1 mark)

(ii) This diagram represents pure iron.



Use the diagram to explain why pure iron is described as an element.

.....

.....

.....

.....

(2 marks)

Question 4 continues on the next page

4.4.1.3 Extraction of metals and reduction

Question 03 · continued

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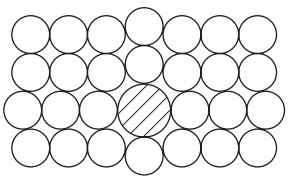
(iii) Pure iron is relatively soft. The iron from the blast furnace is hard and brittle. The diagram below represents iron from the blast furnace.



Use the diagram to explain why iron from the blast furnace is hard and brittle.

.....

.....

.....

.....

(2 marks)

8

4.4.1.3 Extraction of metals and reduction

Question 04

7 Copper is a widely used metal. The main ore of copper contains copper sulfide. Copper can be extracted from copper sulfide in a three stage process.

(a) In the first stage of extraction the copper sulfide is heated in air.

(i) Balance the symbol equation for the reaction.

$$Cu_2S + ...O_2 \rightarrow .....CuO + SO_2$$

(1 mark)

(ii) Explain why there would be an environmental problem if the gas from this reaction were allowed to escape into the atmosphere.

.....

.....

.....

.....

(2 marks)

(b) In the second stage copper oxide, CuO, is reduced using carbon.

Describe and explain what happens during this reaction.

.....

.....

.....

.....

(2 marks)

4.4.1.3 Extraction of metals and reduction

Question 04 · continued

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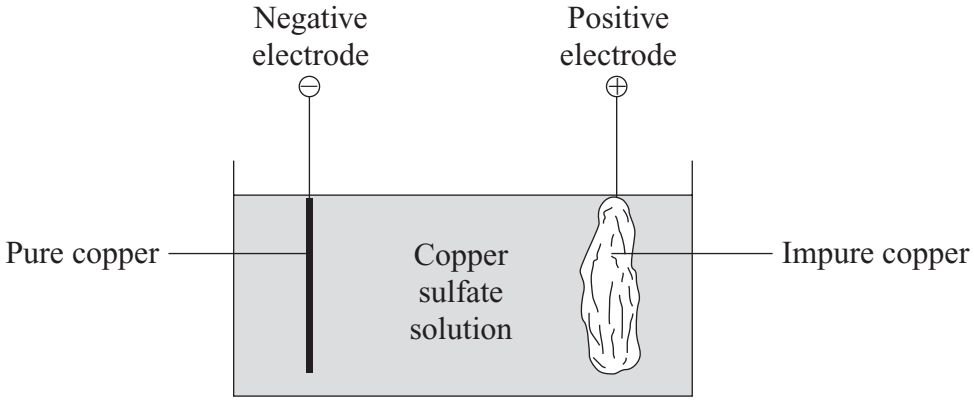
(c) During the third stage the copper can be purified as shown in the diagram.



(i) What is the name of the type of process used for this purification?

.....

(1 mark)

(ii) Give **one** use of purified copper.

.....

(1 mark)

(d) Copper-rich ores are running out.

New ways of extracting copper from low grade ores are being researched.

Recycling of copper may be better than extracting copper from its ores.

Explain why.

.....

.....

.....

.....

.....

.....

(3 marks)

10

4.4.1.3 Extraction of metals and reduction

Question 05

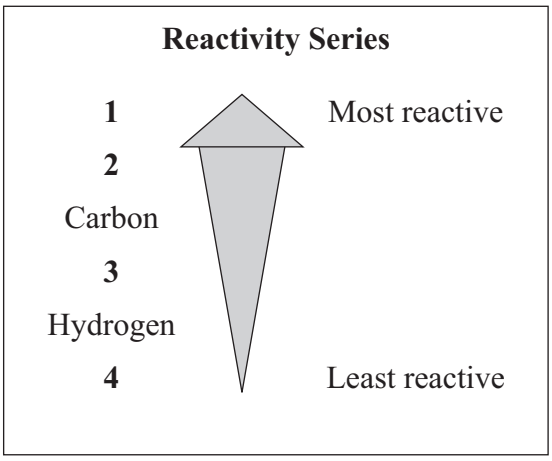
November 2007 | CHY1A | Original Q5 | Legacy

QUESTION FIVE

This question is about the positions of four metals, **A**, **B**, **C** and **D**, in the reactivity series.

- Only metals **A** and **C** can be extracted from their oxides by strongly heating their oxides mixed with carbon.
- Metal **C**, but not metal **A**, can be extracted from its oxide by heating the oxide in a stream of hydrogen.
- Metal **D** is more reactive than metal **B**.

Match metals, **A**, **B**, **C** and **D**, with the numbers **1–4** in the reactivity series.



4.4.1.3 Extraction of metals and reduction

Question 06

November 2007 | CHY1A | Original Q8 | Legacy

QUESTION EIGHT

The table shows the emissions of sulfur dioxide, in the United Kingdom (UK), by different fuels in 1990 and in 2004.

	Emissions of sulfur dioxide by different fuels in thousands of tonnes		
Fuel type	**1990**	**2004**	**Percentage change between 1990 and 2004**
Coal	2707	578	–79
Other solid fuels	66	20	–70
Petroleum fuel oil	605	78	–87
Other petroleum products (including petrol and diesel)	193	83	–57
Gaseous fuels	9	11	+22
Other emissions of sulfur dioxide	118	58	–51
TOTAL	**3698**	**828**	**–78**

- Since 1990, the amount of coal used in the generation of electricity at power stations has reduced by more than 60%.
- Since 1990, gaseous fuels have gradually been replacing fuel oil for electricity generation and in industry.
- The small amount of sulfur dioxide emitted from petrol and diesel fuel used in vehicles has decreased. It should decrease further with the increased use of low-sulfur petrol and diesel.

8A Which fuel had the largest reduction in sulfur dioxide emissions, **in thousands of tonnes**, between 1990 and 2004?

1 coal

2 fuel oil

3 other petroleum products

4 gaseous fuels

8B This data suggests that emissions of sulfur dioxide between 1990 and 2004 . . .

1 decreased for all fuels.

2 decreased by more than 50% for all fuels.

3 decreased by 78% for all fuels except gaseous fuels.

4 decreased by more than 50% for all fuels except gaseous fuels.

8C Which reasonable prediction can be made from the evidence given at the beginning of this question?

1 Sulfur dioxide emissions will begin to increase in the future as the number of vehicles on our roads increases.

2 Overall, sulfur dioxide emissions are likely to continue to decrease.

3 Supplies of fuel oil will be used up in another twenty years.

4 Sulfur dioxide emissions from gaseous fuels will be greater than those from coal in the near future.

8D The data in the table was obtained by estimating the sulfur dioxide emissions from power stations, industrial plants, vehicles, etc.

Sulfur dioxide emissions in the UK could also be monitored by . . .

1 providing each vehicle with a digital readout of sulfur dioxide emitted.

2 measuring the sulfur dioxide concentrations in the air above the largest power stations and industrial plants.

3 measuring the sulfur dioxide concentrations in the air at a large number of sites spread across the UK.

4 measuring the sulfur content of all fuels before they are used.

4.4.1.3 Extraction of metals and reduction

Question 07

November 2007 | CHY1A | Original Q9 | Legacy

QUESTION NINE

Jobs for bacteria – metal miners

Copper is found in the Earth's crust as the ore copper sulfide.

Traditionally, copper-rich ores are roasted and smelted to extract the metal.

Copper compounds can now be extracted from low-grade ores by bioleaching. In one type of bioleaching, the copper compounds are extracted from heaps of the crushed ore using bacteria.

- The bacteria live in the ore and gain their energy by slowly breaking down the copper compounds.
- The bacteria produce acidic solutions in which the copper compounds dissolve from the rocks and can be collected.
- The bacteria usually live at 35 °C to 40 °C. This means that breakdown of the compounds takes place only very slowly in the heaps of crushed ore.
- If these bacteria could work at a temperature 10 °C higher, then it is estimated that the rate of breakdown of the compounds would be twice as fast.

9A Which of the following is a disadvantage of extracting copper by bioleaching rather than by the traditional method?

1 Bioleaching allows us to use low-grade ores.

2 Bioleaching is more economical.

3 Bioleaching is slower.

4 Bioleaching uses less energy.

9B Copper compounds can be extracted more quickly from the ore in tanks at a temperature of 75 °C.

Where might bacteria able to work at this temperature be found?

1 in rivers running through rainforests

2 in polluted rivers

3 in streams on the sides of active volcanoes

4 in tropical seas

9C About 20% of the world's copper is now extracted from low-grade ores by bioleaching.

Some scientists think that this figure will steadily increase in the next few years.

An increase in the use of bioleaching may **not** happen if . . .

1 the price of copper increases dramatically.

2 large new deposits of high-grade ore are discovered.

3 the cost of energy rises quickly.

4 sulfur dioxide levels in the atmosphere reach dangerous levels.

9D Copper can be obtained from solutions containing copper compounds by . . .

1 electrolysis.

2 oxidation.

3 fractionation.

4 combustion.

END OF TEST

4.4.1.3 Extraction of metals and reduction

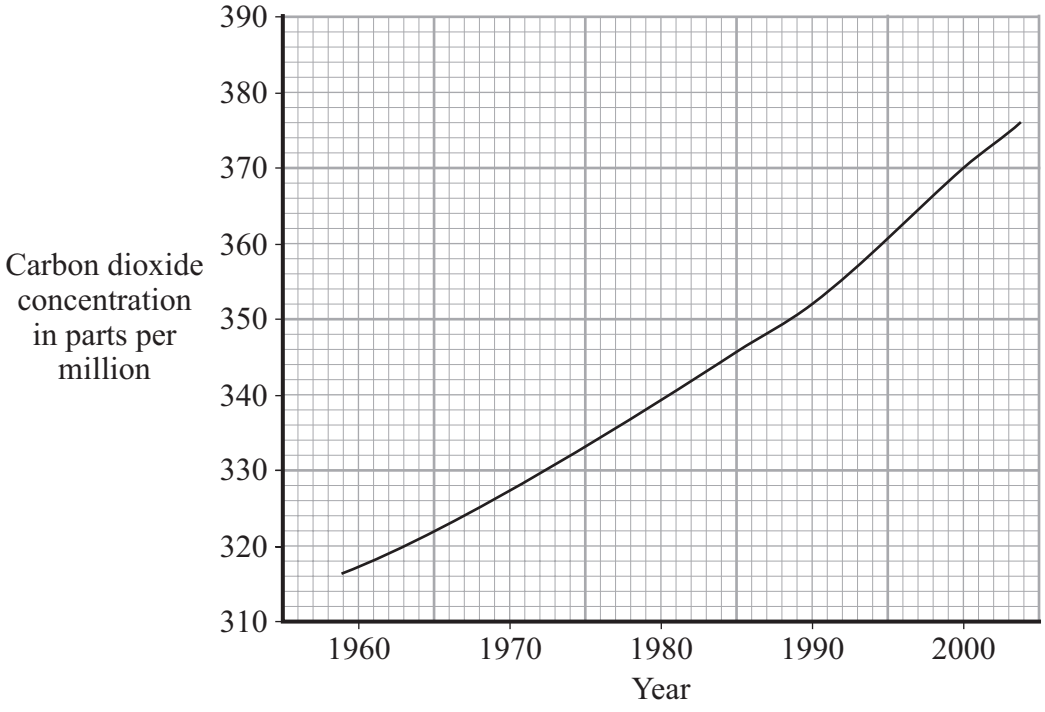
Question 08

November 2007 | CHY1B | Original Q9 | Legacy

QUESTION NINE

Measurements of carbon dioxide in the atmosphere have been made continuously for almost 50 years at the Mauna Loa Observatory, 4000 metres up a mountain in Hawaii.
This site is far enough away from any large carbon dioxide source to be a reliable measuring point.

Atmospheric carbon dioxide levels measured at Mauna Loa, Hawaii



9A What is the mean (average) rate of increase per year of carbon dioxide (in parts per million) in the atmosphere at Mauna Loa between 1990 and 2000?

1 1.8

2 18.0

3 352.0

4 370.0

9B The change in carbon dioxide concentration over the past 50 years is thought to be a result of . . .

1 increased volcanic activity.

2 an increase in the use of fossil fuels.

3 variations in the Sun's energy output.

4 an increase in ocean temperatures.

Question 08 · continued

9C Many scientists think that there is a close link between atmospheric carbon dioxide levels and global warming.
Some political leaders have taken no action to reduce carbon dioxide emissions.

One possible reason is that . . .

1 restrictions on industrial development might result.

2 their countries have few oil reserves.

3 they do not think that scientists are qualified to make important judgements.

4 they do not think that global warming will affect their country.

9D Concerns about carbon dioxide levels and global warming have increased research and technical development in some areas.

Which of these has **not** been part of this development?

1 the use of ethanol as a fuel in cars

2 the use of diesel oil instead of petrol in cars

3 the use of vegetable oils as a fuel in cars

4 the development of electric cars

END OF TEST

4.4.1.3 Extraction of metals and reduction

Question 09

March 2008 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

The word equation shows how tin can be extracted from tin oxide.

$$\text{tin oxide} + \text{carbon} \xrightarrow{\text{heat}} \text{tin} + \text{carbon dioxide}$$

Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A carbon

B carbon dioxide

C tin

D tin oxide

In the reaction above, . . .

the compound obtained from the ore is . . . **1** . . . .

the substance released as a waste gas is . . . **2** . . . .

the element that causes reduction is . . . **3** . . . .

the element produced by this reaction is . . . **4** . . . .

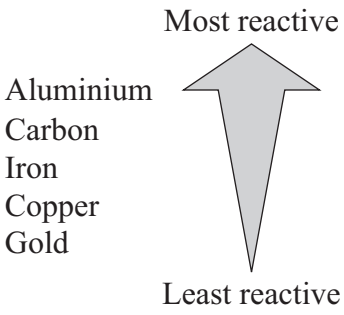
4.4.1.3 Extraction of metals and reduction

Question 10

March 2008 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

This is the order of reactivity for five elements.



Match metals, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A iron

B aluminium

C copper

D gold

	What we can say about the metal
1	It will **not** react with oxygen or water even at high temperatures.
2	It is made in the blast furnace by the reduction of its oxide with carbon.
3	It can be extracted from its molten ore with electricity but **not** with carbon.
4	It can be extracted from its ore with carbon and is purified by electrolysis.

4.4.1.3 Extraction of metals and reduction

Question 11

June 2008 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

- Iron is obtained by reducing its oxide ore with carbon.
- Aluminium **cannot** be obtained by reducing its oxide ore with carbon.
- Gold occurs as the metal itself.

8A From the information above, which row in the table shows the order of reactivity of the four elements?

	most reactive → least reactive			
1	aluminium	carbon	iron	gold
2	iron	aluminium	carbon	gold
3	iron	aluminium	gold	carbon
4	aluminium	iron	gold	carbon

8B Iron obtained directly from the blast furnace was used to build the Iron Bridge in Shropshire.

This bridge is unsuitable for use by modern lorries because . . .

1 it **cannot** be stopped from rusting.

2 it will easily bend out of shape.

3 it is too heavy to support its own weight.

4 it is too brittle and so it will break.

4.4.1.3 Extraction of metals and reduction

Question 11 · continued

- Aluminium waste of high purity can be recycled.
- Any iron and other impurities are removed.
- The aluminium is then melted and processed in the same way as aluminium that has been extracted from its ore.
- Recycling aluminium in this way creates only 5% of the carbon dioxide produced by extracting aluminium from its ore.

8C Which of the following benefits an aluminium recycling company financially?

1 a fall in the price of aluminium

2 the high melting point of aluminium

3 the high purity of the aluminium waste arriving at the recycling plant

4 the metal can be purified by electrolysis

8D An environmental disadvantage of recycling aluminium is that . . .

1 the aluminium waste has to be transported for recycling.

2 land fill sites would **not** be filled so quickly.

3 the process creates only 5% of the carbon dioxide produced by extracting aluminium from its ore.

4 the price of aluminium will fall.

4.4.1.3 Extraction of metals and reduction

Question 12

June 2008 | CHY1F | Original Q6 | Legacy

6 Metals and their alloys have many uses.

6 (a) Dentists use a smart alloy to make braces that gently push teeth into the right position.

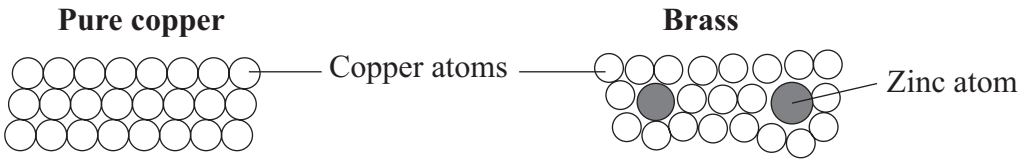
What is meant by a *smart alloy*?

.....

.....

(1 mark)

6 (b) Pure copper is made up of layers of copper atoms. Brass is an *alloy* of copper and zinc.



Why are the physical properties of brass different from the physical properties of pure copper?

.....

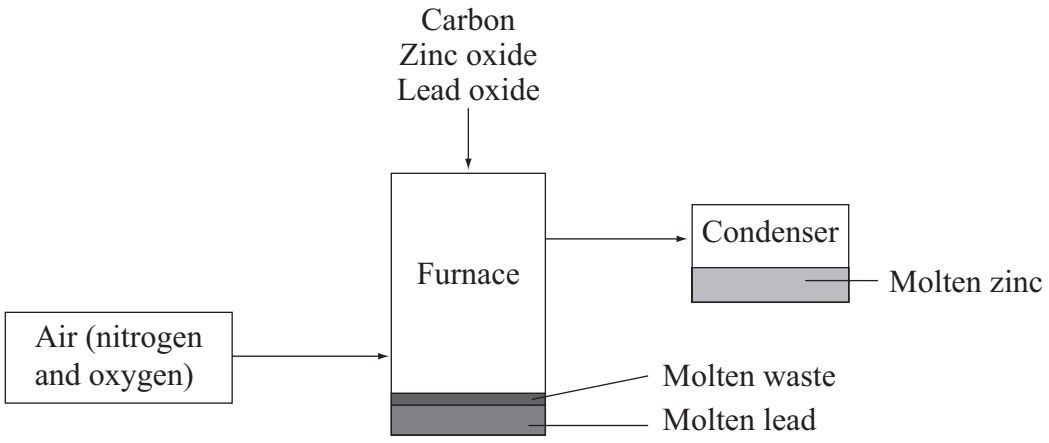
.....

.....

.....

(2 marks)

6 (c) Nearly all zinc is obtained from ores that also contain lead. The metals zinc and lead can be extracted by reducing their oxides using carbon.



4.4.1.3 Extraction of metals and reduction

Question 12 · continued

for mark

6 (c) (i) Choose **one** element from the box below to complete the sentence about the reduction of zinc oxide.

lead	**nitrogen**	**oxygen**

Zinc oxide is reduced by carbon, which takes away..... to leave zinc metal.

(1 mark)

6 (c) (ii) The melting points and boiling points of lead and zinc are given in the table.

Metal	**Lead**	**Zinc**
Melting point in °C	328	420
Boiling point in °C	1740	907

The furnace operates at a temperature of 1200 °C.

Suggest how the lead metal and zinc metal are separated in the furnace.

.....

.....

.....

.....

(2 marks)

6

4.4.1.3 Extraction of metals and reduction

Question 13

November 2008 | CHY1AP | Original Q4 | Legacy

QUESTION FOUR

This question is about copper and its alloys.

Match descriptions, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A a mixture

B expensive to extract from its ore

C a good conductor

D hard-wearing

It is worth recycling copper because it is . . . **1** . . . .

Copper is difficult to separate from an alloy because the alloy is . . . **2** . . . .

Bronze (a copper alloy), has been used for hundreds of years for making coins because it is . . . **3** . . . .

Copper is used for electrical wiring because it is . . . **4** . . . .

4.4.1.3 Extraction of metals and reduction

Question 14

November 2008 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

The extraction of iron involves heating a mixture of iron ore, limestone and coke (carbon) at high temperatures in a blast furnace.

The limestone and iron ore are extracted from large quarries, some of which are found in areas of outstanding natural beauty.

9A Some people are against the development of these large quarries.

One reason is that the quarries . . .

1 attract large numbers of tourists to visit the area.

2 make unsightly scars on the landscape.

3 are unnecessary because there are few uses for limestone.

4 create a dangerous habitat for wildlife.

9B Some people support the development of these quarries.

One reason is that the working quarries . . .

1 are always placed where the public cannot see them.

2 conserve resources.

3 provide employment for people who live in the area.

4 provide an area for leisure activities.

9C Iron is produced continuously, sometimes for several years without shutting down the blast furnace.

This is done . . .

1 because it is difficult to obtain large supplies of limestone.

2 because it takes several years to reach the required temperature in the furnace.

3 to minimise the energy costs.

4 to ensure that the iron is of the highest quality.

4.4.1.3 Extraction of metals and reduction

Question 14 · continued

9D Some iron is obtained by recycling scrap iron.

Why does it take less energy to make iron from scrap iron than to extract the iron from its ore?

1 Scrap iron is an alloy.

2 Scrap iron contains the element sulfur.

3 Scrap iron does **not** have to be reduced using carbon.

4 Corrosion of the scrap iron makes it easier to melt.

END OF TEST

4.4.1.3 Extraction of metals and reduction

Question 15

March 2009 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

Impure iron is produced in a blast furnace by reducing the iron compound found in one of its ores.

Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A carbon

B cast iron

C iron

D iron oxide

The main ore from which iron is extracted contains the compound . . . **1** . . . .

This is reduced in the blast furnace by reacting it with . . . **2** . . . .

The metal produced from the blast furnace contains about 96% . . . **3** . . . .

The product is brittle and is known as . . . **4** . . . .

4.4.1.3 Extraction of metals and reduction

Question 16

June 2009 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about four metal ores.

	Name of ore	Formula	
A	Haematite	Fe_2O_3	Fe = iron; O = oxygen
B	Silver ore	Ag	Ag = silver
C	Chalcopyrite	$CuFeS_2$	Cu = copper; Fe = iron; S = sulfur
D	Bauxite	Al_2O_3	Al = aluminium; O = oxygen

Match ores, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

1	It contains two metals.
2	It is an oxide of iron.
3	It contains the uncombined metal.
4	It cannot be reduced by mixing with carbon then heating.

4.4.1.3 Extraction of metals and reduction

Question 17

June 2009 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

Hybrid cars have both battery-powered motors and petrol engines. Hybrid cars have been developed so they have reduced carbon dioxide emissions when compared with petrol and diesel cars.

Some figures from manufacturers' tests are shown in the table.

Hybrid car	Price	Fuel economy in km per litre of petrol	Carbon dioxide emissions in g per km
K	£18 000	21.6	109
L	£20 000	23.1	104
M	£11 000	26.1	99
N	£16 000	27.1	94

6A The best way to obtain accurate figures for the amount of carbon dioxide emitted by the cars is to drive each car . . .

1 100 m.

2 1 km.

3 1 km five times, and take the highest value.

4 1 km five times, and take an average value.

6B For these cars, as the fuel economy in km per litre of petrol increases, . . .

1 the carbon dioxide emitted by the cars increases.

2 the carbon dioxide emitted by the cars decreases.

3 the cost of the cars increases.

4 the cars use more petrol per km.

4.4.1.3 Extraction of metals and reduction

Question 17 · continued June 2009 | CHY1AP | Original Q6 | Legacy

6C An independent motoring organisation tested the same cars. The values obtained for carbon dioxide emissions were a lot higher than those quoted by the manufacturers.

These values could be considered to be more reliable because the independent motoring organisation . . .

1 is **not** involved in selling cars.

2 is more concerned about environmental issues.

3 used equipment with a greater range.

4 is more likely to be biased.

6D One environmental advantage that a petrol hybrid car has over a conventional petrol car is that . . .

1 when the battery is working, no energy is being used.

2 the addition of a battery makes it lighter.

3 when only the battery is working, no carbon dioxide is being emitted.

4 the car will produce more sulfur dioxide.

4.4.1.3 Extraction of metals and reduction

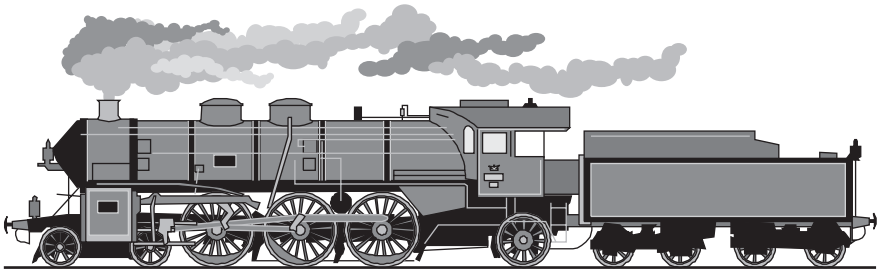
Question 18

June 2009 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

Read the following newspaper extract.

Copper shortage puts the brakes on Flying Scotsman renovation



A major overhaul of the steam locomotive Flying Scotsman has been delayed by more than a year because of the lack of copper for the engine's firebox.

Copper is at a record high price because of huge demand from China's rapidly growing economy. The price had been falling over the previous 30 years, which had discouraged exploration for new supplies.

Other users have been forced to switch to cheaper materials, with plumbers using plastic rather than copper pipes, and telecoms firms using fibre-optic cables rather than copper wire.

9A The firebox of a steam locomotive is where coal is burned to boil water.

Which of these properties is **not** important when using copper in the firebox of a steam locomotive?

1 Copper is a good conductor of heat.

2 Copper has a high melting point.

3 Copper is a good conductor of electricity.

4 Copper is easily hammered and bent into shape.

Question 18 · continued

9B Which row in the table explains why copper was important to plumbers and telecoms firms?

	Plumbers	Telecoms firms
1	High melting point	Good heat conductor
2	Good electrical conductor	High melting point
3	Resistant to corrosion	Good electrical conductor
4	High boiling point	Good electrical conductor

9C Which of the following would make the copper shortage in China and other countries worse?

1 recycling scrap copper rather than burying it in landfill sites

2 developing alternative materials to do the same job as copper

3 extraction of copper from low-grade ores

4 forcing suppliers to reduce the price of copper

9D Why is it environmentally important to recycle copper rather than mine fresh copper ore?

1 Copper ores are non-renewable, and a lot of energy is needed to extract copper from its ore.

2 There are enormous reserves of copper ore which are not expected to run out for hundreds of years.

3 Copper ores are cheap, and scrap copper is easy to dispose of in landfill sites.

4 Copper recycling is difficult and uses more energy when compared with processing new ores.

END OF TEST

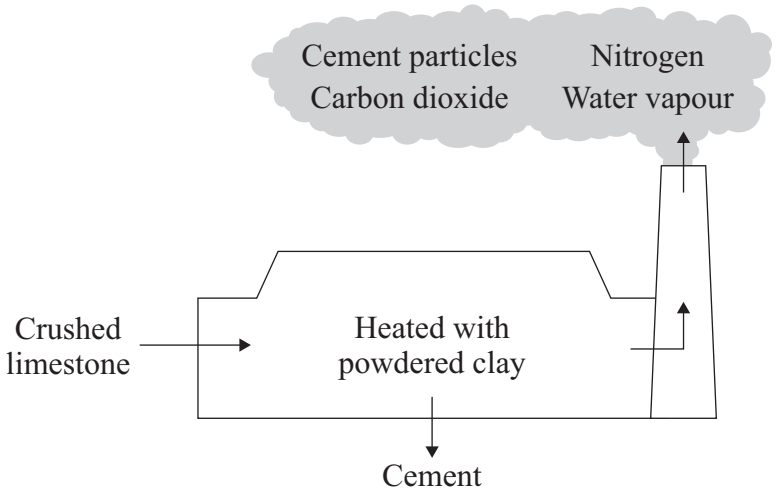
4.4.1.3 Extraction of metals and reduction

Question 19

June 2009 | CHY1F | Original Q6 | Legacy

6 A limestone quarry is in an area of natural beauty and near several villages.
The company operating the quarry wants planning permission to build a new cement works in the quarry.

The diagram shows some of the substances used and produced at a cement works.



6 (a) Limestone is mainly calcium carbonate, $CaCO_3$.
Write the correct number in the box to complete each sentence.

6 (a) (i) The formula shows that calcium carbonate, $CaCO_3$,

contains ☐ different elements.

(1 mark)

6 (a) (ii) Calcium carbonate, $CaCO_3$, contains a total number of ☐ atoms.

(1 mark)

6 (b) The company wants the new cement works because the nearest cement works is 100 km from the quarry. The company argues that a new cement works sited inside the quarry would reduce carbon dioxide emissions.

Suggest why the new cement works might reduce carbon dioxide emissions.

.....

.....

.....

(1 mark)

4.4.1.3 Extraction of metals and reduction

Question 19 · continued

for mark

6 (c) Residents from the villages near the quarry are concerned that there will be atmospheric pollution from the new cement works.

6 (c) (i) Name and explain how **one** of the emissions from the chimney causes atmospheric pollution.

Name of emission: .....

Explanation: .....

.....

(2 marks)

6 (c) (ii) Suggest what the company could do to reduce this atmospheric pollution.

.....

.....

(1 mark)

6

4.4.1.3 Extraction of metals and reduction

Question 20

November 2009 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about metals.

Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A metal ore

B reactive metal

C transition metal

D metal alloy

1	a substance that contains enough metal to make it worth extracting
2	a mixture of metals
3	a metal that is found in the central block of the periodic table
4	a metal that cannot be extracted by reduction using carbon

4.4.1.3 Extraction of metals and reduction

Question 21

November 2009 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

Duralumin is an alloy which contains copper and magnesium mixed with aluminium.

Aluminium is a low density metal but duralumin is used more often in making aeroplanes.

9A Aluminium, copper and magnesium are extracted from their naturally occurring compounds.

The method used for the extraction depends on . . .

1 the density of the metal.

2 the abundance of the metal compound in the Earth's crust.

3 the melting point of the metal compound.

4 the reactivity of the metal.

9B Copper can be extracted by strongly heating a mixture of the copper compound and carbon.

In this reaction, the copper compound is . . .

1 oxidised.

2 electrolysed.

3 reduced.

4 distilled.

9C Aluminium and magnesium are extracted by electrolysis.

One reason why this method is expensive is that . . .

1 the metals are resistant to corrosion.

2 the process requires a large amount of energy.

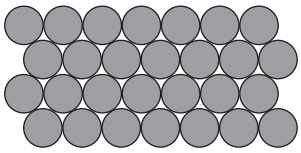
3 the metals are less reactive than carbon.

4 the metal ores are very abundant.

4.4.1.3 Extraction of metals and reduction

Question 21 · continued

9D The diagram shows the arrangement of the atoms in pure aluminium.



Which row in the table correctly shows how the structure and properties are different in duralumin?

	Structure	Properties
1	The layers of atoms are distorted.	The alloy is harder.
2	The copper atoms attach strongly to the aluminium atoms.	The alloy is softer.
3	The layers of atoms are distorted.	The alloy is softer.
4	The magnesium atoms attach strongly to the aluminium atoms.	The alloy is harder.

END OF TEST

4.4.1.3 Extraction of metals and reduction

Question 22

March 2010 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about metals.

Match metals, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A iron

B aluminium

C gold

D stainless steel

1	It is found in the Earth as the metal itself.
2	It is an alloy which is resistant to corrosion.
3	It is extracted by reduction of its oxide in a blast furnace.
4	It is extracted from its oxide by electrolysis.

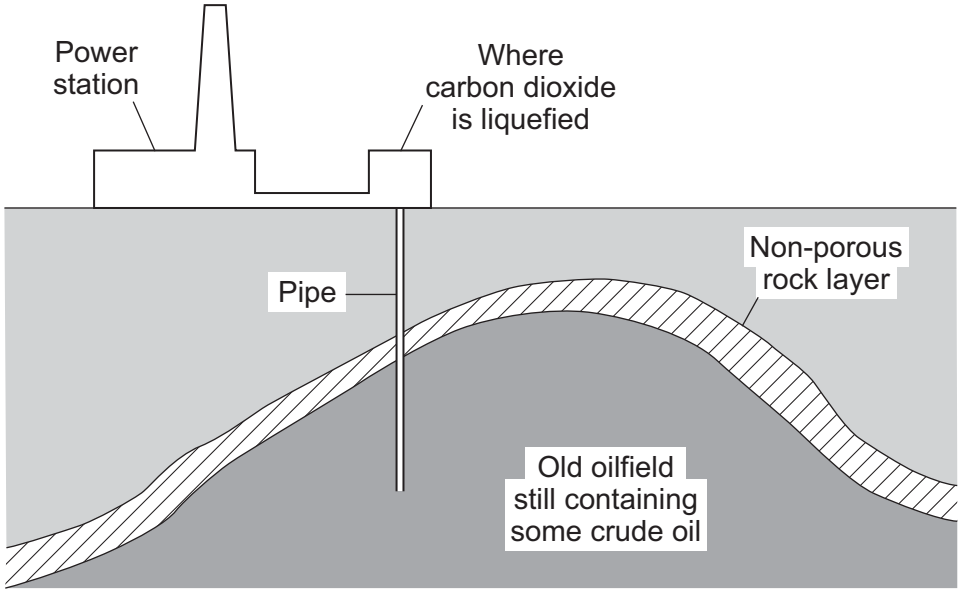
4.4.1.3 Extraction of metals and reduction

Question 23

June 2010 | CHY1AP | Original Q7 | Legacy

QUESTION SEVEN

Carbon capture and storage (CCS) is being developed to reduce the amount of carbon dioxide released into the atmosphere by power stations. Carbon dioxide is separated from the waste gases. It is liquefied and then pumped into a storage area underground. There are many old oilfields that could be used as storage areas.



7A The main reason why CCS is being developed is . . .

1 to reduce global warming.

2 because old oilfields need filling up.

3 because carbon dioxide is toxic.

4 to store carbon dioxide for future use.

7B A possible additional benefit from CCS is that it . . .

1 stops crude oil from rising to the surface.

2 could help to extract any remaining crude oil.

3 prevents the formation of new crude oil.

4 stops the old oilfield from being used as a landfill site.

4.4.1.3 Extraction of metals and reduction

Question 23 · continued

7C The carbon dioxide does not re-enter the atmosphere from the old oilfield . . .

1 because of plants that grow deep underground.

2 because the pipe to the old oilfield is too narrow.

3 because of the non-porous rock layer.

4 because it turns into a fossil fuel.

7D Which of the following might be a problem for CCS?

1 The carbon dioxide is needed in the atmosphere.

2 There are no old oilfields left.

3 Nobody will be burning fossil fuels in the near future.

4 Earthquakes might occur in the old oilfields.

Turn over for the next question

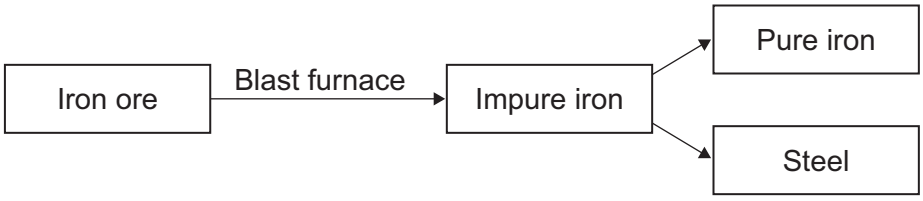
4.4.1.3 Extraction of metals and reduction

Question 24

June 2010 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

The flow chart shows how iron ore can be changed into useful materials.



8A Iron ore is the starting material for making iron because . . .

1 iron ore is magnetic.

2 iron ore contains a reasonable amount of iron oxide.

3 a lot of energy is needed to convert iron ore into iron.

4 mining iron ore does not cause any environmental problems.

8B In the blast furnace, iron oxide is converted to iron using carbon. This is because . . .

1 iron is less reactive than carbon.

2 iron is more reactive than carbon.

3 carbon is a cheap material to use.

4 carbon combines with the metal impurities in the iron ore, leaving iron.

8C Impure iron is hard and brittle. This is because in impure iron . . .

1 the impurities distort the layers of atoms so they cannot slide over each other.

2 the carbon breaks up the iron structure, allowing it to bend easily.

3 its structure has been destroyed by heating to a very high temperature.

4 all the atoms are the same and so remain in a regular arrangement.

8D When impure iron is converted into steel, . . .

1 all the carbon is removed and not replaced.

2 the amount of carbon is carefully controlled.

3 all the metal impurities are removed and not replaced.

4 chromium is always added to the iron.

4.4.1.3 Extraction of metals and reduction

Question 25

November 2010 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

This question is about how we obtain some metals.

Match statements, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A uses another metal

B does **not** use a chemical reaction

C could be done in a blast furnace

D is called electrolysis

1	Aluminium is made when an electric current passes through a molten aluminium compound.
2	Gold can be found at the bottom of some streams.
3	Titanium is made by reacting titanium chloride with magnesium.
4	Zinc is made when a mixture of zinc oxide and carbon is heated.

4.4.1.3 Extraction of metals and reduction

Question 26

November 2010 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

Aluminium is extracted from a substance called bauxite. Bauxite contains aluminium oxide and impurities such as sand. Bauxite is first purified to make pure aluminium oxide. Then electricity is passed through the molten aluminium oxide. The molten aluminium oxide splits to make aluminium and oxygen.

9A Bauxite is an example of . . .

1 an element.

2 a compound.

3 an ore.

4 a solution.

9B The process used to extract aluminium is . . .

1 thermal decomposition.

2 reduction.

3 corrosion.

4 distillation.

9C Aluminium **cannot** be extracted from aluminium oxide using carbon because . . .

1 aluminium is more reactive than carbon.

2 the density of aluminium is too low.

3 carbon is higher in the reactivity series than aluminium.

4 aluminium is covered in a layer of aluminium oxide.

9D Aluminium is often recycled.

Which one of the following is **not** a good reason to recycle aluminium?

1 Recycling is cheaper than extracting aluminium from bauxite.

2 Drinks cans must be made from aluminium.

3 Recycling reduces the amount of energy used to make aluminium.

4 Bauxite reserves will last longer.

END OF TEST

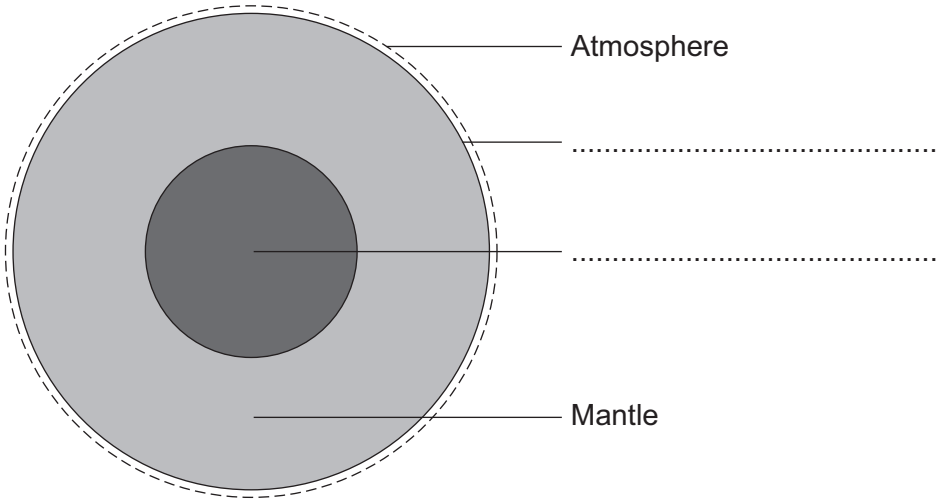
4.4.1.3 Extraction of metals and reduction

Question 27

3 The Earth has a layered structure and is surrounded by an atmosphere.

3 (a) The diagram shows the layers of the Earth.

Complete the labels on the diagram.



(2 marks)

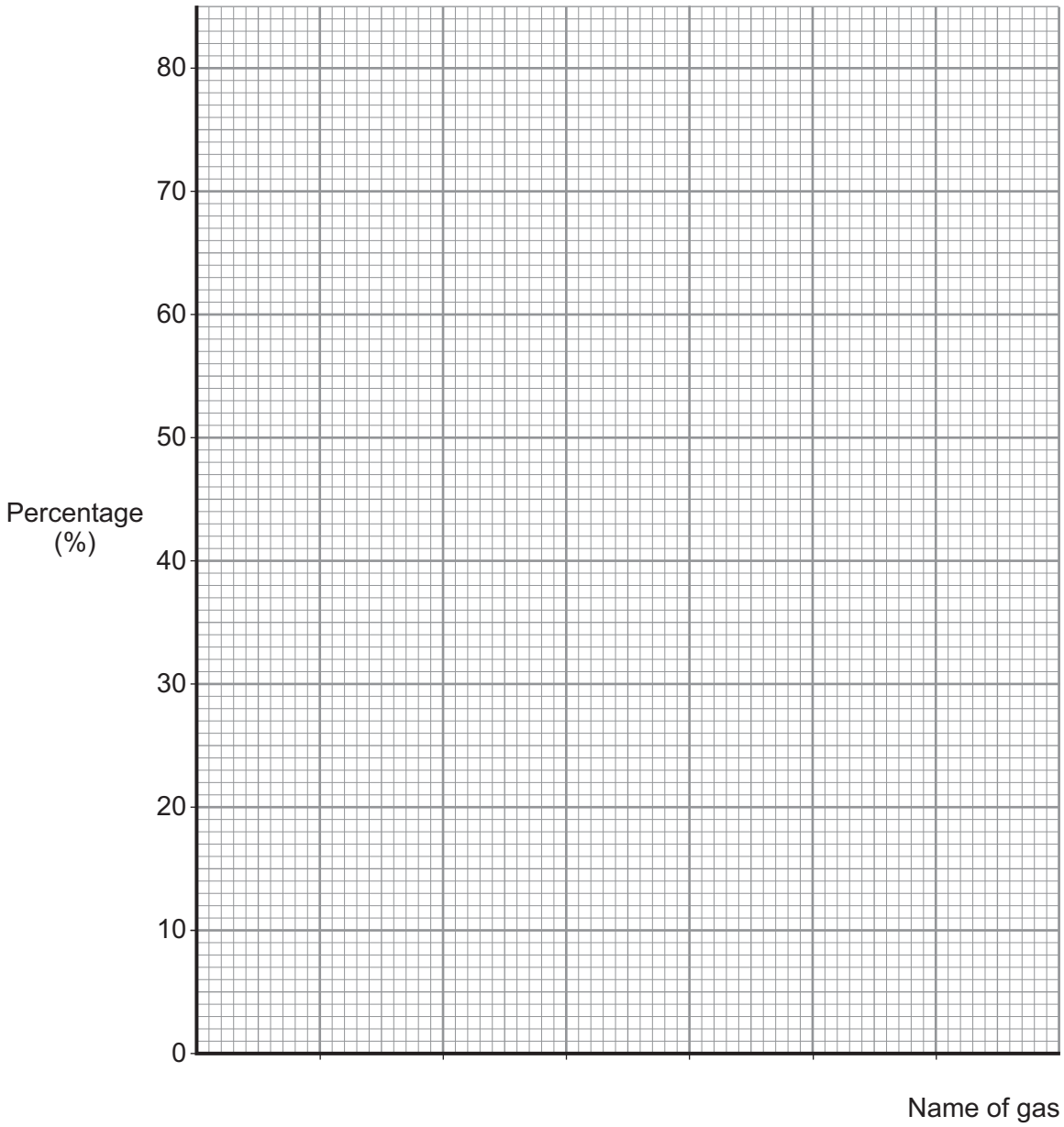
3 (b) The data in the table shows the percentages of the gases in the Earth's atmosphere.

Name of gas	Percentage (%) of gas
Nitrogen	78
Oxygen	21
Other gases	1

4.4.1.3 Extraction of metals and reduction

Question 27 · continued

Present the data in the table on the grid below.



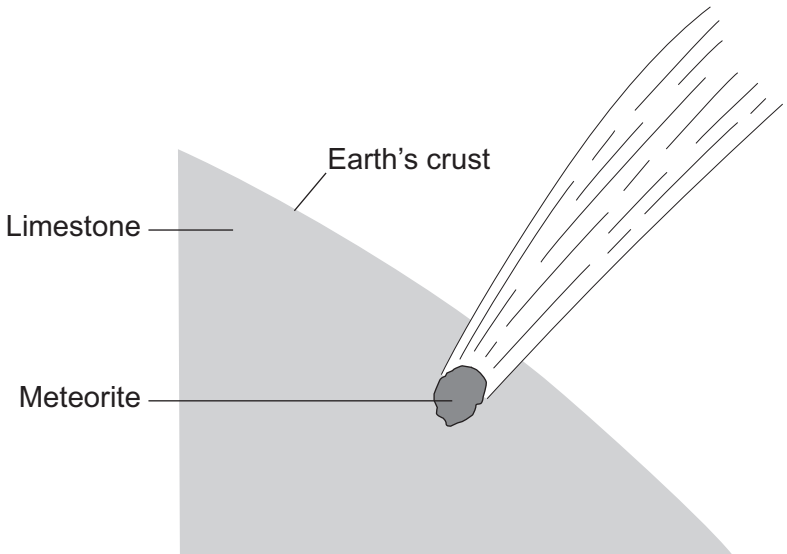
(3 marks)

Question 3 continues on the next page

4.4.1.3 Extraction of metals and reduction

Question 27 · continued

3 (c) Millions of years ago a large meteorite hit the Earth.
The meteorite heated limestone in the Earth's crust to a very high temperature.
The heat caused calcium carbonate in the limestone to release large amounts of carbon dioxide.



Draw a ring round the correct answer to complete each sentence.

3 (c) (i) Carbon dioxide was released because the calcium carbonate was

decomposed.
evaporated.
reduced.

(1 mark)

3 (c) (ii) More carbon dioxide in the Earth's atmosphere causes

acid rain.
global dimming.
global warming.

(1 mark)

7

4.4.1.3 Extraction of metals and reduction

Question 28

January 2011 | CHY1F | Original Q6 | Legacy

6 The flow diagram shows the main stages used to extract a metal from its ore.

mining the ore → purifying the ore → extracting the metal

The table shows some information about three metals.

Metal	Metal ore	Purified ore	% of metal in the ore	% of metal in the Earth's crust
aluminium	bauxite	aluminium oxide, Al_2O_3	28.0	8.0
copper	chalcocite	copper sulfide, Cu_2S	0.5	0.001
iron	haematite	iron oxide, Fe_2O_3	29.0	5.0

6 (a) Use the information in the table and your knowledge and understanding to help you to answer the questions.

6 (a) (i) Suggest why purifying the copper ore produces large quantities of waste.

.....

.....

.....

(1 mark)

6 (a) (ii) Suggest why the annual world production of iron is forty times greater than that of aluminium.

.....

.....

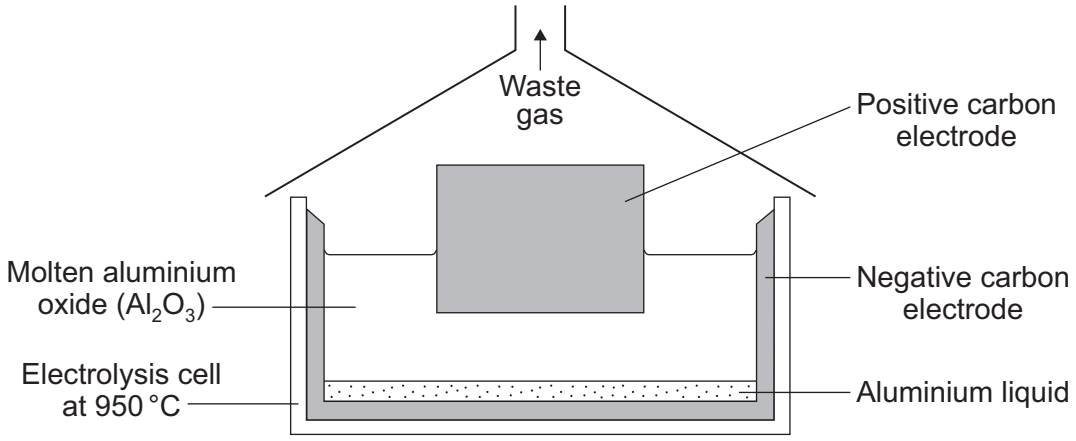
.....

(1 mark)

4.4.1.3 Extraction of metals and reduction

Question 28 · continued

6 (b) Aluminium is used for drinks cans.
Aluminium is extracted from its purified ore by electrolysis.



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

.....

.....

(1 mark)

6 (b) (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.

.....

.....

.....

.....

(2 marks)

6 (b) (iii) Aluminium is the most abundant metal in the Earth's crust.

Suggest **two** reasons why we should recycle aluminium drinks cans.

1 .....

.....

2 .....

.....

(2 marks)

7

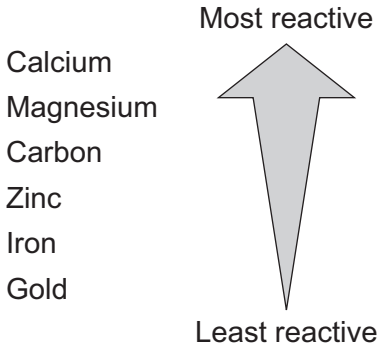
4.4.1.3 Extraction of metals and reduction

Question 29

March 2011 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

This is the order of reactivity for some elements.



Match elements, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A Carbon

B Gold

C Magnesium

D Zinc

1	It is a non-metal element.
2	It does not react with oxygen or water even at high temperatures.
3	It is more reactive than iron but **can** be extracted from its oxide by mixing with carbon and heating the mixture.
4	It is less reactive than calcium but **cannot** be extracted from its oxide by mixing with carbon and heating the mixture.

4.4.1.3 Extraction of metals and reduction

Question 30

March 2011 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

This question is about the extraction and recycling of copper.

Copper is used in its pure form or mixed with other metals.
Large amounts of scrap copper metal from a variety of sources can easily be recycled by re-melting.

9A Pure copper can be extracted directly by . . .

1 thermal decomposition of copper carbonate.

2 thermal decomposition of copper oxide.

3 carbon reduction of copper oxide in a blast furnace.

4 electrolysis of copper compounds dissolved in water.

9B Small amounts of other metals are sometimes added to copper to produce . . .

1 compounds that conduct electricity better.

2 compounds that are softer.

3 alloys that are harder.

4 new elements that are harder.

9C The price of copper would increase if there was . . .

1 a decrease in the demand for copper.

2 an increase in energy costs.

3 an increase in the amount of copper being recycled.

4 a discovery of a low grade copper ore in a remote area of the world.

9D One **disadvantage** of recycling copper is that it . . .

1 prevents heaps of scrap metal from building up.

2 still requires the use of energy resources.

3 will increase the price of copper.

4 will contaminate the world's supplies of copper.

END OF TEST

4.4.1.3 Extraction of metals and reduction

Question 31

June 2011 | CHY1AP | Original Q4 | Legacy

QUESTION FOUR

The table gives some information about four metals, **A**, **B**, **C** and **D**.

	Metal	Main ore	Price in £ per tonne	Percentage abundance of the metal in the Earth's crust
A	Aluminium	Bauxite, Al_2O_3	1800	7
B	Copper	Chalcopyrite, $CuFeS_2$	3300	0.005
C	Tin	Cassiterite, SnO_2	8000	0.0002
D	Iron	Haematite, Fe_2O_3	30	4

Match metals, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table below.

1	It is the least expensive metal.
2	It is the least abundant metal.
3	The main ore of this metal is not an oxide.
4	This metal cannot be obtained from its main ore by reduction with carbon.

4.4.1.3 Extraction of metals and reduction

Question 32

June 2011 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

Copper is in high demand. Copper is extracted from ores containing copper sulfide. Most of these ores contain only low percentages of copper sulfide.

The copper sulfide is heated in a furnace. Oxygen is blown through the molten copper sulfide. Copper and sulfur dioxide are produced.

6A A company uses copper sulfide ores to produce copper.

The company will make more profit if . . .

1 the cost of the fuel to heat the furnace increases.

2 the ores contain a higher percentage of copper sulfide.

3 their workers are paid more.

4 there is a reduced demand for copper.

6B The company wants to know the amount of sulfur dioxide released into the atmosphere from the chemical works.

It would be best to measure the amount of sulfur dioxide . . .

1 in the nearest town.

2 in the area around the chemical works.

3 in the gases coming out of the chimneys at the chemical works.

4 in the country as a whole.

4.4.1.3 Extraction of metals and reduction

Question 32 · continued

6C The company wants to know the total amount of sulfur dioxide given off by the chemical works in a 24-hour period.

The best way to calculate this would be from measurements taken . . .

1 at midday.

2 at 10.00 am and 10.00 pm.

3 at 9.00 am, midday and 4.00 pm.

4 every hour.

6D Ores containing very low percentages of copper sulfide are being used to produce copper.

One factor that would increase the use of these ores is . . .

1 the discovery of large deposits of high grade copper ore.

2 an increase in the use of plastics instead of copper for water pipes.

3 a large increase in the price of copper.

4 an increase in the amount of copper that is recycled.

4.4.1.3 Extraction of metals and reduction

Question 33

November 2011 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

This question is about iron and steel.

Match properties, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A hard

B resistant to corrosion

C easily shaped

D brittle

Iron from the blast furnace has few uses because it is . . . **1** . . . .

Low-carbon steel is used to make car body panels because it is . . . **2** . . . .

High-carbon steel is used to make knives because it is . . . **3** . . . .

Stainless steel is used to make kitchen sinks because it is . . . **4** . . . .

4.4.1.3 Extraction of metals and reduction

Question 34

November 2011 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

Iron oxide can be reduced to iron by mixing the oxide with carbon and heating strongly.

Aluminium oxide cannot be reduced to aluminium in this way. Aluminium is obtained from aluminium oxide by electrolysis.

9A Why is it possible to obtain iron but not aluminium by carbon reduction?

1 Iron is more reactive than aluminium.

2 Carbon is more reactive than aluminium but less reactive than iron.

3 Carbon is more reactive than iron but less reactive than aluminium.

4 Aluminium and iron are both more reactive than carbon.

9B The extraction of aluminium by electrolysis is an expensive process because . . .

1 aluminium easily corrodes in air.

2 a large amount of energy is needed.

3 aluminium oxide is difficult to mine.

4 aluminium reacts with carbon.

9C As electrolysis is expensive, an increasing amount of aluminium is being recycled.

Another important reason to recycle aluminium is that . . .

1 it saves limited aluminium oxide reserves.

2 the recycled aluminium is purer.

3 aluminium scrap does not corrode easily.

4 recycling aluminium does not use energy.

4.4.1.3 Extraction of metals and reduction

Question 34 · continued

9D Which two of the following statements could explain why aluminium is preferred to iron for making cans for drinks?

W Aluminium has a lower density than iron.

X Aluminium is a better conductor than iron.

Y Aluminium corrodes less easily than iron.

Z Aluminium is not as strong as iron.

1 **W** and **X**

2 **W** and **Y**

3 **X** and **Y**

4 **Y** and **Z**

END OF TEST

4.4.1.3 Extraction of metals and reduction

Question 35

January 2012 | CH1FP | Original Q2 | Legacy

2 Cans for food and drinks are made from steel or aluminium.
The main metal in steel is iron.

2 (a) Reacting iron oxide with carbon produces iron.

Draw a ring around the correct answer to complete the sentence.

The reaction to produce iron from iron oxide is

- decomposition.
- oxidation.
- reduction.

(1 mark)

2 (b) Aluminium cannot be produced by reacting aluminium oxide with carbon.

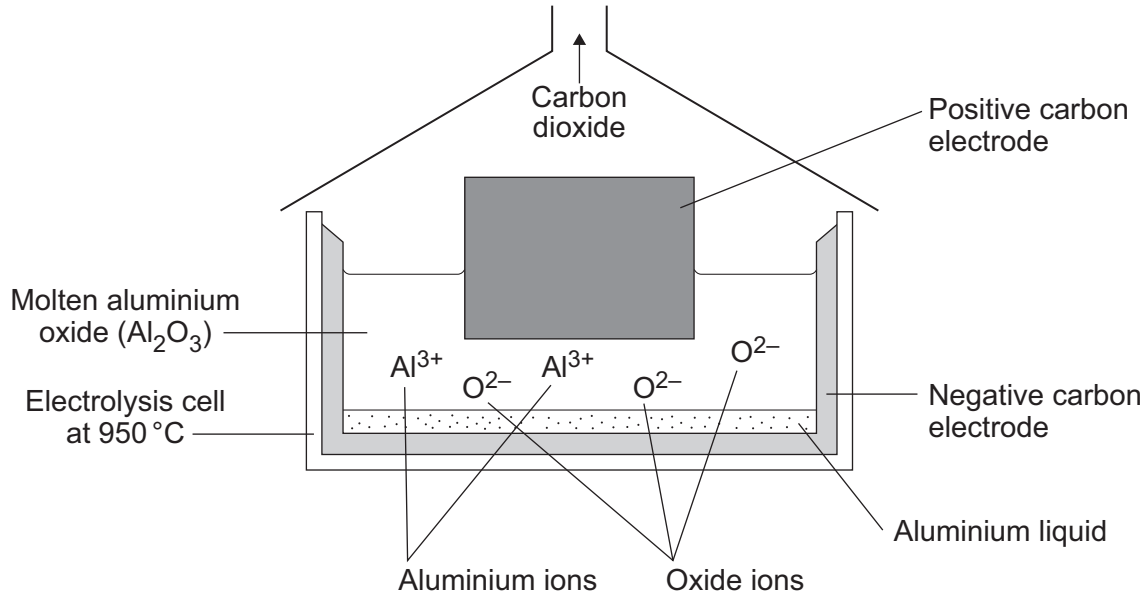
Why does aluminium oxide **not** react with carbon?

Tick (✓) the correct answer.

Answer	Tick (✓)
aluminium is less reactive than carbon	
carbon is less reactive than aluminium	
oxygen is more reactive than carbon	

(1 mark)

2 (c) Aluminium can be produced by electrolysis.



Question 35 · continued

Why do the aluminium ions collect at the negative electrode?

.....

.....

.....

.....

(2 marks)

2 (d) Some statements about aluminium are given below.

Tick (✓) **two** statements that are correct reasons why aluminium is used to make cans.

Statement	Tick (✓)
aluminium conducts electricity	
aluminium is not a transition metal	
aluminium has a low density	
aluminium is resistant to corrosion	

(2 marks)

2 (e) Recycling aluminium cans uses less fossil fuels than producing aluminium from its ore.

Tick (✓) **one** advantage and tick (✓) **one** disadvantage of recycling aluminium to make aluminium cans.

Statement	Advantage Tick (✓)	Disadvantage Tick (✓)
aluminium is the most common metal in the Earth's crust		
less carbon dioxide is produced		
more aluminium ore needs to be mined		
used aluminium cans have to be collected and transported		

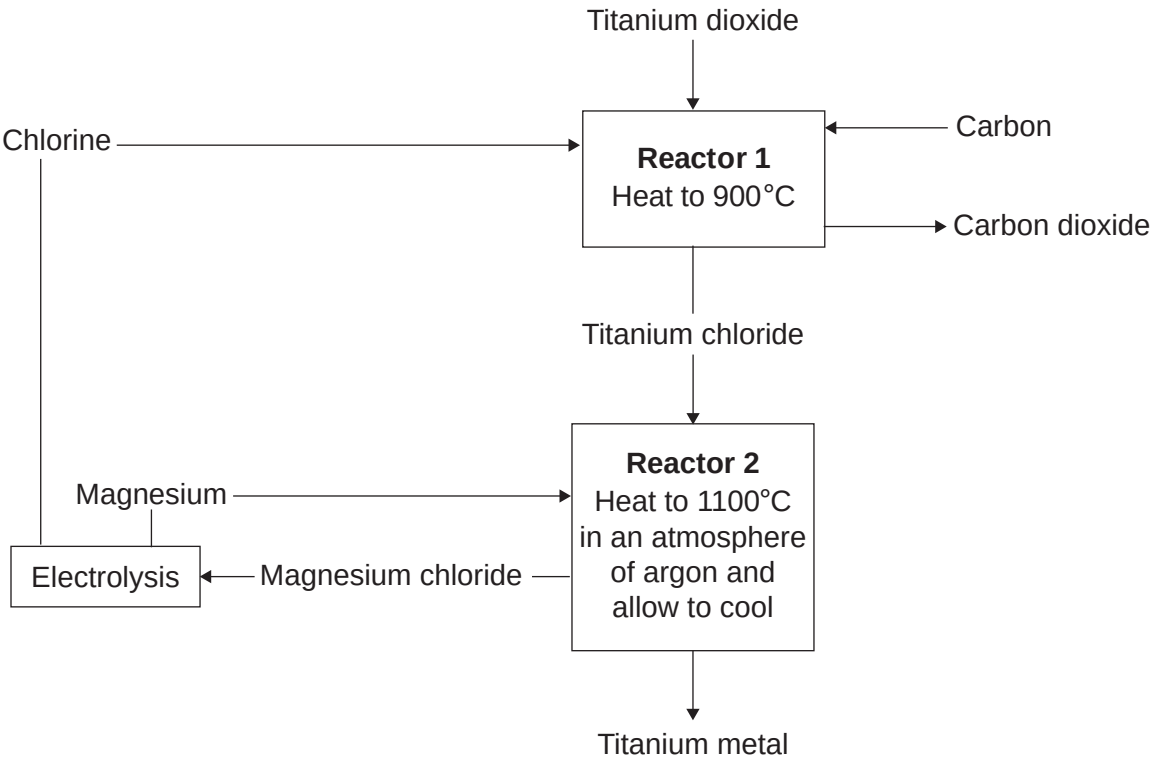
(2 marks)

8

4.4.1.3 Extraction of metals and reduction

Question 36

7 Rutile is an ore of titanium. Rutile contains titanium dioxide.
The flow chart shows how titanium metal is extracted from titanium dioxide.



7 (a) Titanium is much more expensive than iron.

Give **one** reason why.

.....

.....

(1 mark)

7 (b) Name the only waste product shown on the flow chart.

.....

(1 mark)

4.4.1.3 Extraction of metals and reduction

Question 36 · continued

7 (c) Describe the example of recycling shown on the flow chart.

.....

.....

.....

.....

(2 marks)

7 (d) The air is removed from **Reactor 2**. An atmosphere of argon is used for the reaction between titanium chloride and magnesium metal.

Explain why.

.....

.....

.....

.....

(2 marks)

Question 7 continues on the next page

4.4.1.3 Extraction of metals and reduction

Question 36 · continued

7 (e) Titanium metal is produced by reacting titanium chloride with magnesium.

950 kg of titanium chloride was mixed with 240 kg of magnesium metal. The mixture was heated and produced 950 kg of magnesium chloride.

Calculate the mass of titanium metal produced.

.....

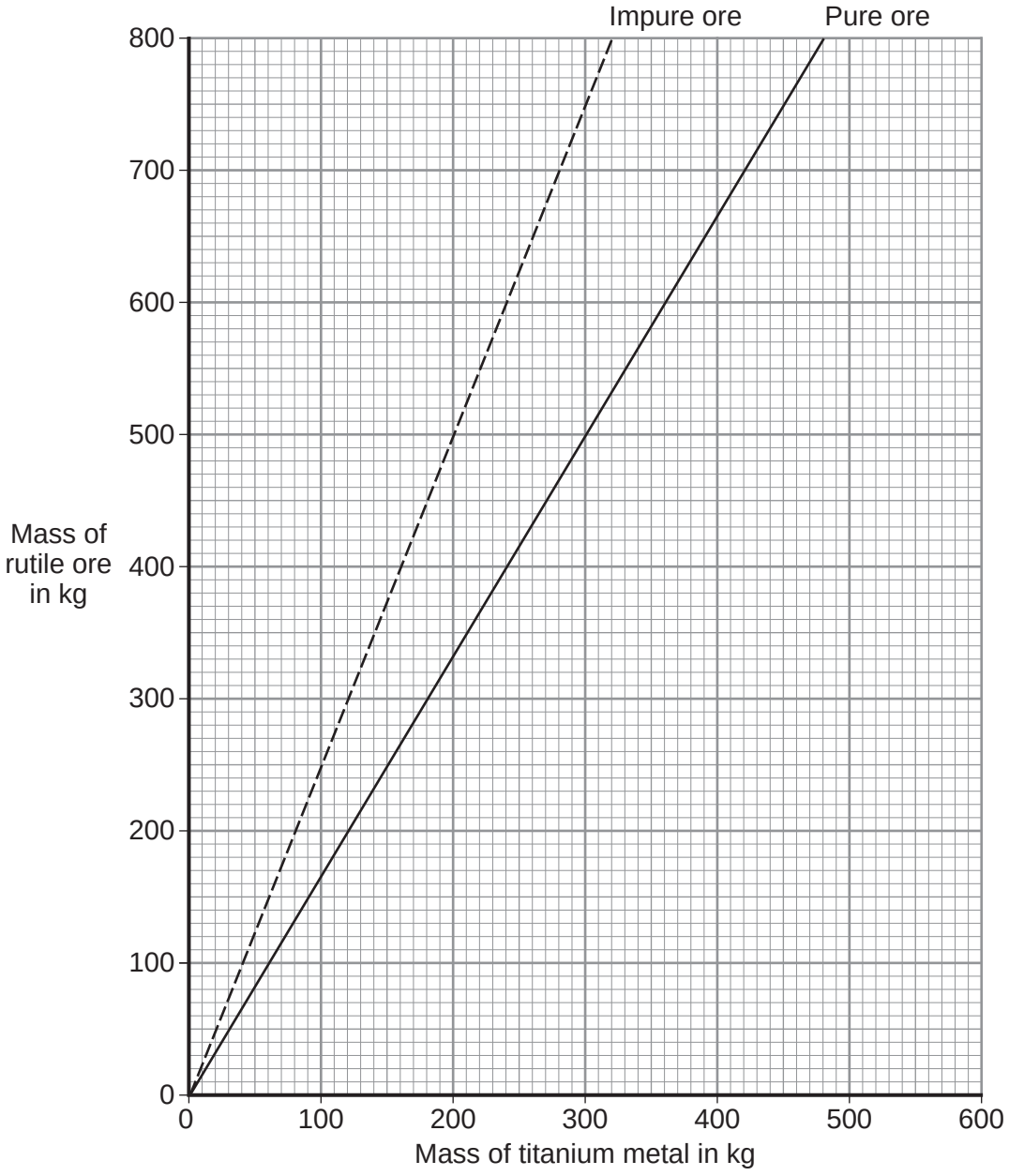
Mass = ... kg

(1 mark)

4.4.1.3 Extraction of metals and reduction

Question 36 · continued

7 (f) The graph shows the mass of titanium metal produced from a pure rutile ore and from an impure rutile ore.



The difference between the two lines represents the amount of waste rock in the impure ore.

300 kg of titanium metal was produced from the impure ore.

Calculate the mass of waste rock in the impure ore.

.....

Mass = ... kg

(1 mark)

8

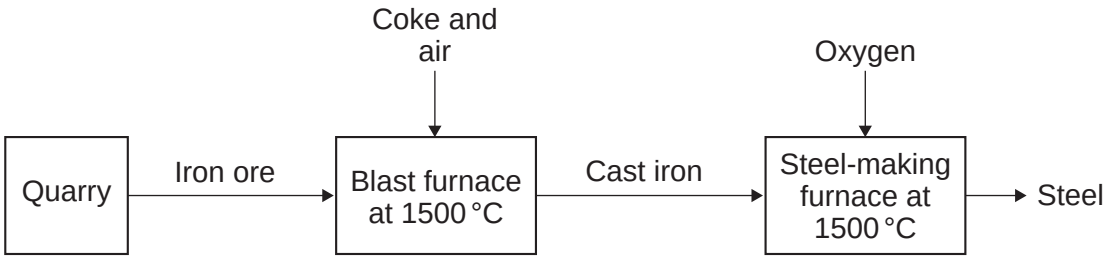
4.4.1.3 Extraction of metals and reduction

Question 37

January 2013 | CH1FP | Original Q4 | Legacy

4 The iron produced from iron ore in a blast furnace is called cast iron.

Cast iron is converted into steel in a furnace.



Iron ore contains iron oxide.
Coke contains carbon.

4 (a) Quarrying iron ore will have an impact on everything near to the quarry.

4 (a) (i) Describe **one** positive impact and **one** negative impact of quarrying iron ore.

positive impact .....

.....

negative impact.....

.....

(2 marks)

4 (a) (ii) Draw a ring around the correct answer to complete the sentence.

Ores contain enough metal to make extraction of the metal

carbon neutral.

economical.

reversible.

(1 mark)

4 (b) Many chemical reactions take place in a blast furnace.
Use the flow diagram to help you to answer this question.

Suggest how the blast furnace is heated.

.....

.....

(1 mark)

4.4.1.3 Extraction of metals and reduction

Question 37 · continued

4 (c) A chemical reaction for the extraction of iron is:

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

4 (c) (i) Complete the word equation for this chemical reaction.

..... + carbon monoxide → iron + ...

(2 marks)

4 (c) (ii) Draw a ring around the correct answer to complete the sentence.

Iron is extracted from its ore by

- decomposition.
- oxidation.
- reduction.

(1 mark)

4 (d) Cast iron contains about 4% carbon.
Cast iron is converted into low-carbon steels.

4 (d) (i) Low-carbon steel is produced by blowing oxygen into molten cast iron.

Suggest how oxygen removes most of the carbon.

.....

.....

.....

.....

(2 marks)

4 (d) (ii) Draw a ring around the correct answer to complete the sentence.

Metals, such as nickel, are added to low-carbon steels to make the steel

- corrode easily.
- easy to shape.
- much harder.

(1 mark)

Question 4 continues on the next page

4.4.1.3 Extraction of metals and reduction

Question 37 · continued

4 (e) Recycling steel uses less energy than producing steel from iron ore.

Tick (✓) **one** advantage and tick (✓) **one** disadvantage of recycling steel.

Statement	Advantage Tick (✓)	Disadvantage Tick (✓)
Iron is the second most common metal in the Earth's crust.		
Less carbon dioxide is produced.		
More iron ore needs to be mined.		
There are different types of steel which must be sorted.		

(2 marks)

12

4.4.1.3 Extraction of metals and reduction

Question 38

June 2013 | CH1FP | Original Q7 | Legacy

7 Metals are extracted from their ores.

Many copper ores contain only 2% of copper compounds.

7 (a) Copper is now extracted from ores containing a low percentage of copper compounds.

Suggest **two** reasons why.

.....

.....

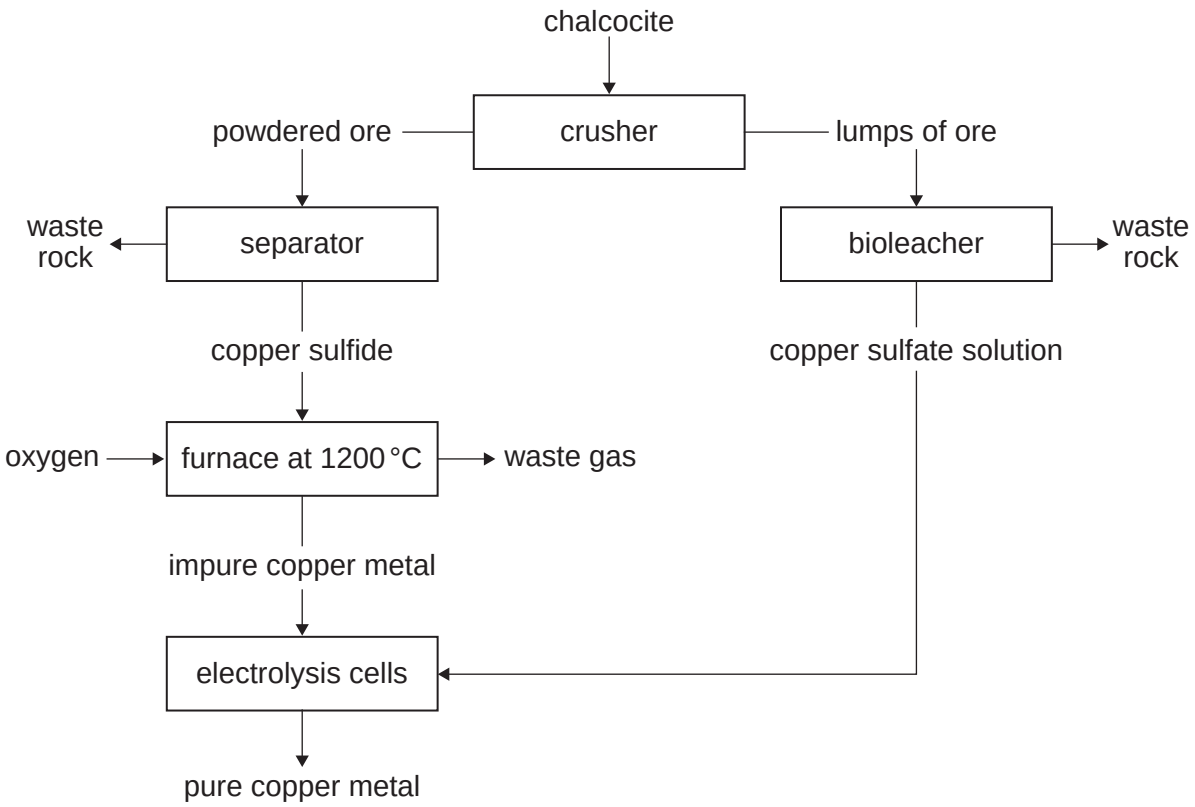
.....

.....

(2 marks)

7 (b) Chalcocite, an ore of copper, contains copper sulfide.

The flow diagram shows how copper metal is extracted from chalcocite.



4.4.1.3 Extraction of metals and reduction

Question 38 · continued

7 (b) (i) Suggest **one** reason why it is difficult to dispose of the waste rock.

.....

.....

(1 mark)

7 (b) (ii) The reaction in the furnace could cause environmental pollution.
Explain how.

.....

.....

.....

.....

(2 marks)

7 (b) (iii) The extraction of pure copper is expensive.
Give **one** reason why.

.....

.....

(1 mark)

7 (b) (iv) Pure copper is produced by electrolysis of copper sulfate solution.

Which electrode do the copper ions move towards?
Give a reason for your answer.

.....

.....

.....

.....

(2 marks)

7 (b) (v) Large areas of land are contaminated with copper compounds.
Phytomining can be used to remove these copper compounds from the land.

What is used in phytomining to remove copper compounds from the land?

.....

.....

(1 mark)

9

4.4.1.3 Extraction of metals and reduction

Question 39

June 2014 | CH1FP | Original Q5 | Legacy

5 Where copper ore has been mined there are areas of land that contain very low percentages of copper compounds.

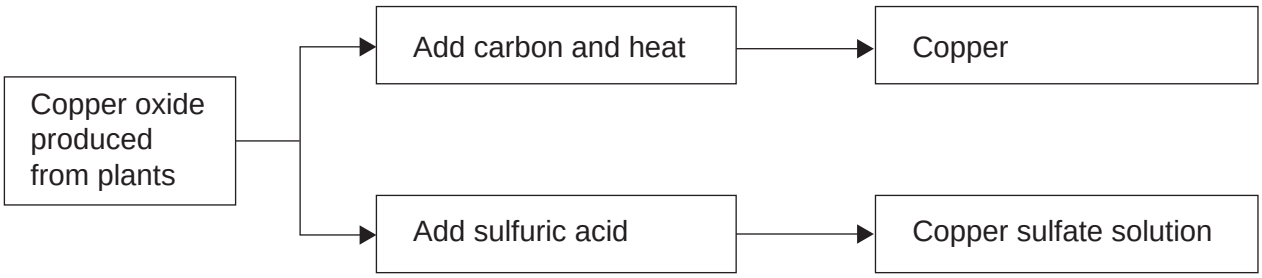
One way to extract the copper is to grow plants on the land.

The plants absorb copper compounds through their roots.

The plants are burned to produce copper oxide.

The copper oxide produced from plants can be reacted to produce copper or copper sulfate solution, as shown in **Figure 6**.

Figure 6



5 (a) Draw a ring around the correct answer to complete each sentence.

5 (a) (i) Copper ores contain enough copper to make extraction of the metal

carbon neutral.
economical.
reversible.

[1 mark]

5 (a) (ii) Using plants to extract metals is called

photosynthesis.
phytomining.
polymerisation.

[1 mark]

5 (a) (iii) Copper oxide reacts with carbon to produce copper and

carbon dioxide.
oxygen.
sulfur dioxide.

[1 mark]

4.4.1.3 Extraction of metals and reduction

Question 39 · continued

5 (b) Copper is produced from copper sulfate solution by displacement using iron or by electrolysis.

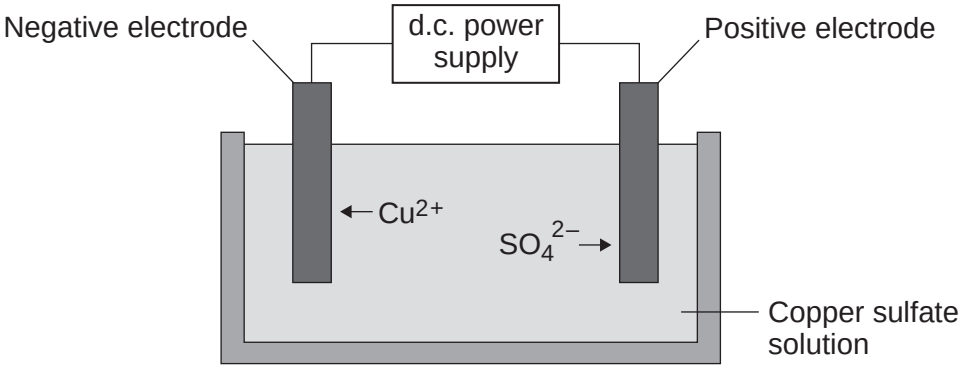
5 (b) (i) Complete the word equation.

[2 marks]

copper sulfate + iron ⟶ ..... + ...

5 (b) (ii) **Figure 7** shows the electrolysis of copper sulfate solution.

Figure 7



Why do copper ions go to the negative electrode?

[1 mark]

.....

.....

5 (c) Suggest **two** reasons why copper should **not** be disposed of in landfill sites.

[2 marks]

.....

.....

.....

.....

8

4.4.1.3 Extraction of metals and reduction

Question 40

June 2015 | CH1FP | Original Q2 | Legacy

2 Copper is a transition metal.

2 (a) (i) Where is copper in the periodic table?

[1 mark]

Tick (✓) **one** box.

in the central block ☐

in Group 1 ☐

in the noble gas group ☐

2 (a) (ii) What is a property of copper?

[1 mark]

Tick (✓) **one** box.

breaks easily ☐

conducts electricity ☐

does not conduct heat ☐

4.4.1.3 Extraction of metals and reduction

Question 40 · continued

2 (b) Copper ores are quarried by digging large holes in the ground, as shown in **Figure 3**.

Figure 3



Give **two** reasons why quarrying is bad for the environment.

[2 marks]

.....

.....

.....

.....

Question 2 continues on the next page

4.4.1.3 Extraction of metals and reduction

Question 40 · continued

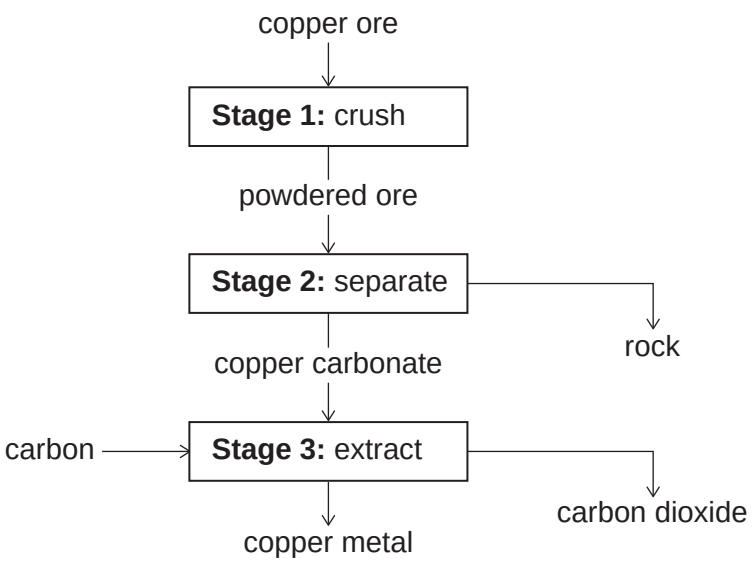
2 (c) Some copper ores contain only 2% copper.

Most of the ore is rock that is not needed.

In one ore, the main compound is copper carbonate ($CuCO_3$).

Figure 4 shows the stages used in the extraction of copper from this ore.

Figure 4



2 (c) (i) Why is **Stage 2** important?

[1 mark]

.....

.....

4.4.1.3 Extraction of metals and reduction

Question 40 · continued

2 (c) (ii) The equation for the reaction in **Stage 3** is:

$$2\,CuCO_3 + C \longrightarrow 2\,Cu + 3\,CO_2$$

From the symbol equation a company calculated that 247 tonnes of copper carbonate are needed to produce 127 tonnes of copper and 132 tonnes of carbon dioxide are released.

Calculate the mass of carbon needed to make 127 tonnes of copper.

[2 marks]

copper carbonate	+	carbon	⟶	copper	+	carbon dioxide
247 tonnes		..... tonnes		127 tonnes		132 tonnes

.....

.....

2 (c) (iii) Suggest **one** reason why it is important for the company to calculate the mass of reactants in **Stage 3**.

[1 mark]

.....

.....

8

4.4.1.3 Extraction of metals and reduction

Question 41

June 2016 | CH1FP | Original Q3 | Legacy

3 Metals are extracted from ores in the Earth's crust.

3 (a) Why is copper used in the manufacture of computers?

[1 mark]

Tick (✓) **one** box.

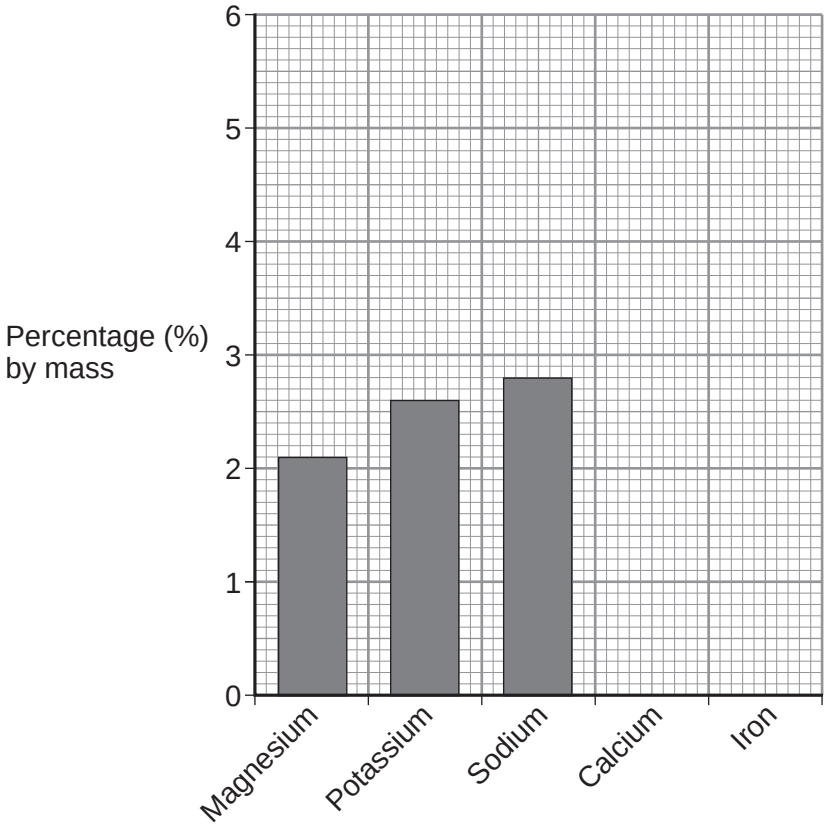
Because it has a high density. ☐

Because it does not react with water. ☐

Because it is a good conductor of electricity. ☐

3 (b) **Figure 6** shows the percentage (%) by mass of some metals in the Earth's crust.

Figure 6



4.4.1.3 Extraction of metals and reduction

Question 41 · continued

3 (b) (i) What is the percentage by mass of magnesium in the Earth's crust?

[1 mark]

_____ %

3 (b) (ii) On **Figure 6** draw the bars for:

- calcium at 3.6% by mass
- iron at 5.0% by mass.

[2 marks]

3 (c) An ore of zinc contains zinc carbonate.

The equation for the reaction when zinc carbonate is heated is:

$$\underset{\text{zinc carbonate}}{ZnCO_3} \longrightarrow \underset{\text{zinc oxide}}{ZnO} + \underset{\text{carbon dioxide}}{CO_2}$$

3 (c) (i) What is the name of this type of reaction?

[1 mark]

Tick (✓) **one** box.

corrosion ☐

decomposition ☐

electrolysis ☐

3 (c) (ii) Which substance in the equation is a gas at room temperature (20 °C)?

[1 mark]

Tick (✓) **one** box.

zinc carbonate ☐

zinc oxide ☐

carbon dioxide ☐

Question 3 continues on the next page

4.4.1.3 Extraction of metals and reduction

Question 41 · continued

3 (c) (iii) Complete **Table 1** to show the number of atoms of carbon and oxygen in the formula of zinc carbonate.

[2 marks]

Table 1

Element	Number of atoms in the formula $ZnCO_3$
zinc, Zn	1
carbon, C	
oxygen, O	

3 (c) (iv) When 125 g zinc carbonate is heated, 81 g zinc oxide is produced.

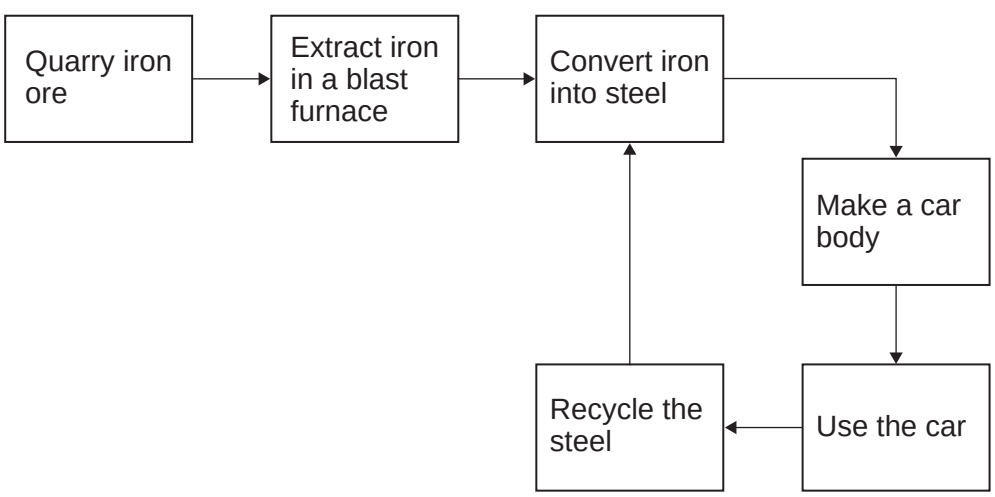
Calculate the mass of carbon dioxide produced.

[1 mark]

Mass of carbon dioxide = _____ g

3 (d) **Figure 7** shows a simple life cycle of a car body.

Figure 7



4.4.1.3 Extraction of metals and reduction

Question 41 · continued

3 (d) (i) What is **one** reason why iron from the blast furnace is converted into steel?

[1 mark]

Tick (✓) **one** box.

To make the iron pure. ☐

To make the iron more brittle. ☐

To make alloys for specific uses. ☐

3 (d) (ii) Apart from cost, give **three different** reasons why steel should be recycled.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

13

4.4.1.3 Extraction of metals and reduction

Question 42

June 2017 | CH1FP | Original Q3 | Legacy

3 This question is about metals.

3 (a) Complete the word equation for the reaction of magnesium with oxygen.

[1 mark]

magnesium + oxygen ⟶ _____

3 (b) Iron oxide is reduced to iron in a blast furnace.

The chemical equation for the reaction is:

$$2\ Fe_2O_3 + 3\ C \longrightarrow 4\ Fe + 3\ CO_2$$

3 (b) (i) Give the name of the element used for the reduction of iron oxide.

[1 mark]

_____

3 (b) (ii) How can you tell that iron oxide is reduced?

[1 mark]

_____

_____

3 (b) (iii) Complete the sentences.

[3 marks]

For many uses, iron from the blast furnace is too _____ .

For many uses, pure iron is too _____ .

Mixtures of iron with carbon are called _____ .

6

4.4.1.3 Extraction of metals and reduction

Question 43

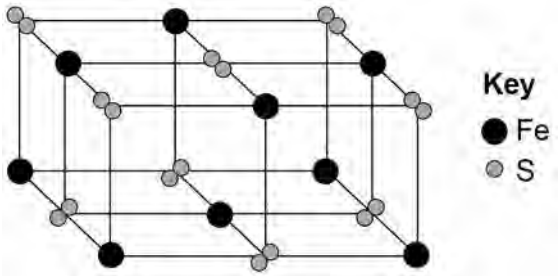
June 2018 | 8462/1F | Original Q9

0 9 This question is about metals and metal compounds.

0 9 . 1 Iron pyrites is an ionic compound.

Figure 12 shows a structure for iron pyrites.

Figure 12



Determine the formula of iron pyrites.

Use **Figure 12**.

[1 mark]

_____

0 9 . 2 An atom of iron is represented as $^{56}_{26}Fe$

Give the number of protons, neutrons and electrons in this atom of iron.

[3 marks]

Number of protons _____

Number of neutrons _____

Number of electrons _____

0 9 . 3 Iron is a transition metal.

Sodium is a Group 1 metal.

Give **two** differences between the properties of iron and sodium.

[2 marks]

1 _____

_____

2 _____

_____

4.4.1.3 Extraction of metals and reduction

Question 43 · continued

Nickel is extracted from nickel oxide by reduction with carbon.

0 9 . 4 Explain why carbon can be used to extract nickel from nickel oxide.

[2 marks]

0 9 . 5 An equation for the reaction is:

$$NiO + C \rightarrow Ni + CO$$

Calculate the percentage atom economy for the reaction to produce nickel.

Relative atomic masses (A_r): C = 12 Ni = 59

Relative formula mass (M_r): NiO = 75

Give your answer to 3 significant figures.

[3 marks]

Percentage atom economy = _____ %

11

4.4.1.3 Extraction of metals and reduction

Question 44

0 6 This question is about the extraction of metals.

0 6 . 1 Tungsten is a metal.

The symbol of tungsten is W

Tungsten is produced from tungsten oxide by reaction with hydrogen.

The equation for the reaction is:

$$WO_3 + 3H_2 \rightarrow W + 3H_2O$$

Calculate the percentage atom economy when tungsten is produced in this reaction.

Use the equation:

$$\text{percentage atom economy} = \frac{184}{(M_r\ WO_3) + (3 \times M_r\ H_2)} \times 100$$

Relative formula masses (M_r): $WO_3 = 232$ $H_2 = 2$

[2 marks]

Percentage atom economy = _____ %

4.4.1.3 Extraction of metals and reduction

Question 44 · continued

Aluminium is extracted from aluminium oxide.

0 6 . 2 38% of a rock sample is aluminium oxide.

Calculate the mass of aluminium oxide in 40 kg of the rock sample.

[2 marks]

Mass of aluminium oxide = _____ kg

0 6 . 3 The formula of aluminium oxide is Al_2O_3

Calculate the relative formula mass (M_r) of aluminium oxide.

Relative atomic masses (A_r): O = 16 Al = 27

[2 marks]

Relative formula mass (M_r) = _____

Question 6 continues on the next page

4.4.1.3 Extraction of metals and reduction

Question 44 · continued

0 6 . 4 60.0 kg of aluminium oxide produces a maximum of 31.8 kg of aluminium.

In an extraction process only 28.4 kg of aluminium is produced from 60.0 kg of aluminium oxide.

Calculate the percentage yield.

Give your answer to 3 significant figures.

Use the equation:

$$\text{percentage yield} = \frac{\text{mass of product actually made}}{\text{maximum theoretical mass of product}} \times 100$$

[3 marks]

Percentage yield = _____ %

0 6 . 5 Extracting metals by electrolysis is a very expensive process.

Explain why aluminium is extracted using electrolysis and not by reduction with carbon.

[2 marks]

11

4.4.1.3 Extraction of metals and reduction

Question 45

November 2020 | 8462/1F | Original Q9

0 9 This question is about metals and the reactivity series.

0 9 . 1 Which **two** statements are properties of most transition metals?

[2 marks]

Tick (✓) **two** boxes.

- They are soft metals. ☐
- They form colourless compounds. ☐
- They form ions with different charges. ☐
- They have high melting points. ☐
- They have low densities. ☐

0 9 . 2 A student added copper metal to colourless silver nitrate solution.

The student observed:

- pale grey crystals forming
- the solution turning blue.

Explain how these observations show that silver is less reactive than copper.

[3 marks]

4.4.1.3 Extraction of metals and reduction

Question 45 · continued

0 9 . 3 A student is given three metals, **X**, **Y** and **Z** to identify.

The metals are magnesium, iron and copper.

Plan an investigation to identify the three metals by comparing their reactions with dilute hydrochloric acid.

Your plan should give valid results.

[4 marks]

Question 9 continues on the next page

Question 45 · continued

0 9 . 4 Metal **M** has two isotopes.

Table 6 shows the mass numbers and percentage abundances of the isotopes.

Table 6

Mass number	Percentage abundance (%)
203	30
205	70

Calculate the relative atomic mass (A_r) of metal **M**.

Give your answer to 1 decimal place.

[2 marks]

Relative atomic mass (1 decimal place) = _____

11

4.4.1.3 Extraction of metals and reduction

Question 46

November 2021 | 8462/1F | Original Q10

1 0 This question is about the extraction of metals.

Element **R** is extracted from its oxide by reduction with hydrogen.

The equation for the reaction is:

$$3\,H_2 + \mathbf{R}O_3 \rightarrow \mathbf{R} + 3\,H_2O$$

1 0 . 1 The sum of the relative formula masses (M_r) of the reactants ($3\,H_2$ + $\mathbf{R}O_3$) is 150

Calculate the relative atomic mass (A_r) of **R**.

Relative atomic masses (A_r): H = 1 O = 16

[2 marks]

Relative atomic mass (A_r) of **R** = _____

1 0 . 2 Identify element **R**.

You should use:

- your answer to **question 10.1**
- the periodic table.

[1 mark]

Identity of **R** = _____

4.4.1.3 Extraction of metals and reduction

Question 46 · continued

1 0 . 3 Carbon is used to extract tin (Sn) from tin oxide (SnO_2).

The equation for the reaction is:

$$SnO_2 + C \rightarrow Sn + CO_2$$

Calculate the percentage atom economy for extracting tin in this reaction.

Relative atomic masses (A_r): C = 12 O = 16 Sn = 119

[3 marks]

Percentage atom economy = _____ %

Question 10 continues on the next page

4.4.1.3 Extraction of metals and reduction

Question 46 · continued

1 0 . 4 Tungsten (W) is a metal.

Tungsten is extracted from tungsten oxide (WO_3).

All other solid products from the extraction method must be separated from the tungsten.

Table 9 shows information about three possible methods to extract tungsten from tungsten oxide.

Table 9

Method	Reactant	Relative cost of reactant	Products
1	Carbon	Low	Tungsten solid Carbon dioxide gas Tungsten carbide solid
2	Hydrogen	High	Tungsten solid Water vapour
3	Iron	Low	Tungsten solid Iron oxide solid

Evaluate the three possible methods for extracting tungsten from tungsten oxide.

[4 marks]

10

4.4.1.3 Extraction of metals and reduction

Question 47

June 2022 | 8462/1F | Original Q8

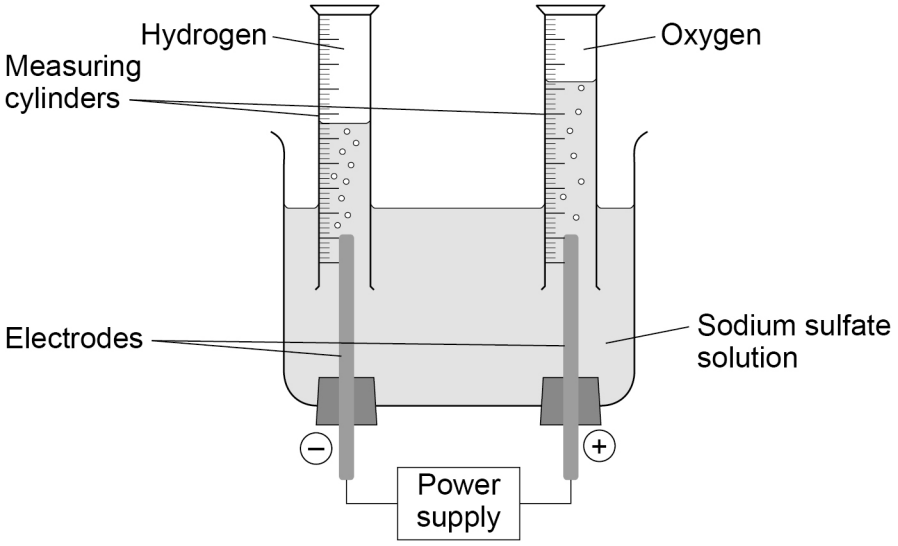
0 8 This question is about electrolysis.

Ionic compounds decompose when they are electrolysed.

A student electrolyses sodium sulfate solution.

Figure 13 shows the apparatus used.

Figure 13



0 8 . 1 Sodium sulfate solution contains:

- hydrogen ions
- hydroxide ions
- sodium ions
- sulfate ions.

Oxygen is produced at the positive electrode.

Which ions are discharged at the positive electrode to produce oxygen?

[1 mark]

Tick (✓) **one** box.

Hydrogen ions ☐

Hydroxide ions ☐

Sodium ions ☐

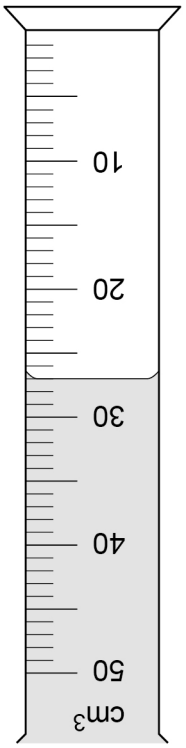
Sulfate ions ☐

4.4.1.3 Extraction of metals and reduction

Question 47 · continued

0 8 . 2 **Figure 14** shows one of the measuring cylinders during the electrolysis.

Figure 14



What is the volume of gas in the measuring cylinder?

[1 mark]

Volume of gas = _____ cm^3

0 8 . 3 Ionic compounds can be electrolysed when molten or dissolved in water.

Why can ionic compounds **not** be electrolysed when solid?

You should answer in terms of ions.

[1 mark]

_____

_____

Question 47 · continued

0 8 . 4 **Table 7** shows the products of electrolysis of two molten compounds.

Table 7

Molten compound	Product at negative electrode	Product at positive electrode
Potassium iodide	Potassium	_____
Zinc bromide	_____	Bromine

Complete **Table 7**.

[2 marks]

0 8 . 5 The electrolysis of molten sodium chloride is used to extract sodium metal.

Why is sodium metal extracted by electrolysis instead of by reduction with carbon?

[1 mark]

Tick (✓) **one** box.

Carbon conducts electricity. ☐

Carbon is less reactive than sodium. ☐

Carbon reduction uses more energy. ☐

0 8 . 6 What is the state symbol for molten sodium chloride?

[1 mark]

Tick (✓) **one** box.

(aq) ☐ (g) ☐ (l) ☐ (s) ☐

4.4.1.3 Extraction of metals and reduction

Question 47 · continued

0 8 . 7 Titanium can be produced from titanium oxide by electrolysis.

The equation for the reaction is:

$$TiO_2 \rightarrow Ti + O_2$$

Calculate the percentage atom economy for the production of titanium from titanium oxide by electrolysis.

Use the equation:

$$\text{Percentage atom economy} = \frac{\text{Relative atomic mass of desired product}}{\text{Relative formula mass of reactant}} \times 100$$

Relative atomic mass (A_r): Ti = 48

Relative formula mass (M_r): TiO_2 = 80

[2 marks]

Percentage atom economy = _____ %

9

4.4.1.3 Extraction of metals and reduction

Question 48

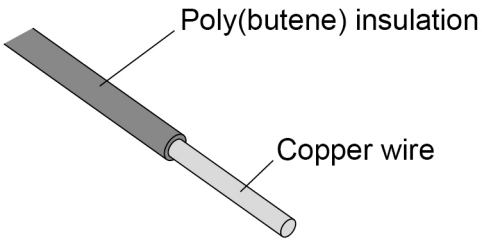
June 2022 | 8462/2F | Original Q8

0 8 This question is about copper wire and copper compounds.

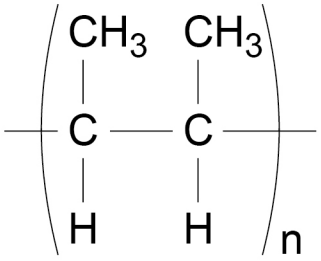
Copper is used to make electrical wires.

Figure 9 shows how copper electrical wire is insulated using an addition polymer called poly(butene).

Figure 9



0 8 . 1 The addition polymer poly(butene) has the displayed structural formula:

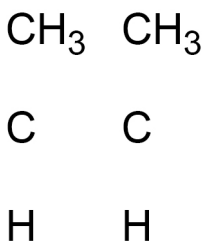


Poly(butene) is produced from the monomer butene.

Complete **Figure 10** to show the displayed structural formula of butene.

[2 marks]

Figure 10



4.4.1.3 Extraction of metals and reduction

Question 48 · continued

Copper can be obtained by recycling scrap copper wire.

0 8 . 2 Suggest why poly(butene) insulation must be removed from scrap copper wire before the copper is recycled.

[1 mark]

0 8 . 3 Describe how scrap copper wire can be recycled to make new copper water pipes.

[2 marks]

0 8 . 4 Suggest **two** reasons why recycling scrap copper is more sustainable than extracting copper from copper ores.

[2 marks]

1

2

Question 8 continues on the next page

4.4.1.3 Extraction of metals and reduction

Question 48 · continued

Copper sulfate is a compound of copper.

Copper sulfate solution contains copper(II) ions and sulfate ions.

0 8 . 5 A solution can be added to copper sulfate solution to show the presence of copper(II) ions.

Name the solution added.

Give the result of the test.

[2 marks]

Name of solution added _____

_____

Result _____

_____

0 8 . 6 Describe **one** test to show the presence of sulfate ions in copper sulfate solution.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

11

4.4.1.3 Extraction of metals and reduction

Question 49

June 2023 | 8462/1F | Original Q8

0 8 This question is about displacement reactions.

Iron is extracted from iron oxide by a displacement reaction with carbon.

0 8 . 1 Balance the equation for the reaction.

[2 marks]

$$Fe_2O_3 + 3\,C \rightarrow ____Fe + ____CO$$

0 8 . 2 Iron oxide is reduced in this reaction.

How does the equation show that iron oxide is reduced?

[1 mark]

_____

_____

0 8 . 3 Calculate the relative formula mass (M_r) of Fe_2O_3

Relative atomic masses (A_r): O = 16 Fe = 56

[2 marks]

_____

_____

_____

M_r = _____

Question 8 continues on the next page

Question 49 · continued

0 8 . 4 Copper oxide reacts with hydrogen to produce copper.

The equation for the reaction is:

$$CuO + H_2 \rightarrow Cu + H_2O$$

Calculate the percentage atom economy for obtaining copper from this reaction.

Use the equation:

$$\text{Percentage atom economy} = \frac{A_r \text{ of Cu}}{M_r \text{ of } H_2 + M_r \text{ of CuO}} \times 100$$

Relative atomic mass (A_r): Cu = 63.5
Relative formula masses (M_r): H_2 = 2 CuO = 79.5

[2 marks]

Percentage atom economy = _____ %

A student investigated the reactivity of four different metals, **A**, **B**, **C** and **D**.

The student:

- added each metal to aqueous solutions of each of the metal sulfates
- observed whether a reaction took place.

0 8 . 5 Give **one** observation that would show a reaction took place.

[1 mark]

4.4.1.3 Extraction of metals and reduction

Question 49 · continued

0 8 . 6 **Table 4** shows the results.

Table 4

	Metal sulfate solution			
Metal	**A sulfate**	**B sulfate**	**C sulfate**	**D sulfate**
A	×	×	✓	×
B	✓	×	✓	×
C	×	×	×	×
D	✓	✓	✓	×

✓ shows that a displacement reaction took place.
× shows that a displacement reaction did not take place.

Write metals **A**, **B**, **C** and **D** in order of reactivity.

Give a reason for your order of reactivity.

[2 marks]

Most reactive _____

_____

_____

Least reactive _____

Reason _____

_____

10

4.4.1.3 Extraction of metals and reduction

Question 50

June 2024 | 8462/1F | Original Q6

0 6 This question is about electrolysis and the extraction of metals.

0 6 . 1 Why can some molten substances be electrolysed?

[1 mark]

Tick (✓) **one** box.

Electrons can move through the molten substance to the electrodes. ☐

Ions can move through the molten substance to the electrodes. ☐

Protons can move through the molten substance to the electrodes. ☐

0 6 . 2 **Table 3** shows the products of the electrolysis of some molten compounds.

Complete **Table 3**.

[3 marks]

Table 3

Molten compound	Product at negative electrode	Product at positive electrode
Lead chloride	_____	Chlorine
Potassium iodide	Potassium	_____
_____	Zinc	Bromine

Question 50 · continued

Aluminium is extracted by electrolysing molten aluminium oxide.

0 6 . 3 Balance the equation for the reaction.

Choose numbers from the box.

[2 marks]

2	**3**	**4**	**5**

$$2Al_2O_3 \rightarrow __ Al + __ O_2$$

0 6 . 4 Calculate the relative formula mass (M_r) of aluminium oxide (Al_2O_3).

Relative atomic masses (A_r): O = 16 Al = 27

[2 marks]

Relative formula mass (M_r) = _____

Question 6 continues on the next page

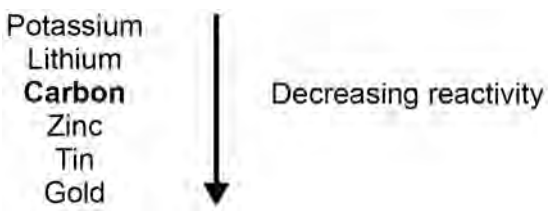
4.4.1.3 Extraction of metals and reduction

Question 50 · continued

0 6 . 5 **Figure 13** shows part of the reactivity series of metals.

The non-metal carbon has been included.

Figure 13



Metals can be extracted from their compounds by:

- electrolysis
- reduction with carbon.

Electrolysis is more expensive than reduction with carbon.

Predict one metal that would be extracted by each method.

Use Figure 13.

[2 marks]

Extracted by electrolysis _____

Extracted by carbon reduction _____

10

Question 51

June 2025 | 8462/1F | Original Q5

0 5 This question is about electrolysis.

0 5 . 1 **Table 4** shows some of the products of electrolysis of two molten compounds.

Complete **Table 4**.

[2 marks]

Table 4

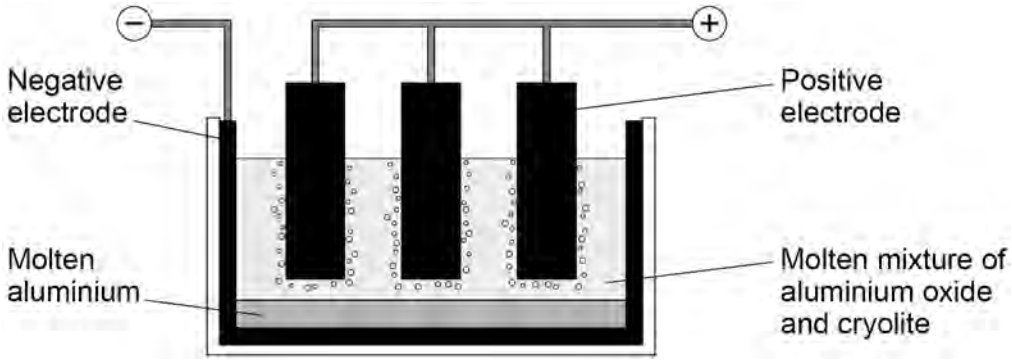
Molten compound	Product at the negative electrode	Product at the positive electrode
Copper chloride		Chlorine
Potassium bromide	Potassium	

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

The products are molten aluminium and oxygen gas.

Figure 4 shows the electrolysis cell.

Figure 4



0 5 . 2 What is the formula of oxygen gas?

[1 mark]

Tick (✓) **one** box.

O ☐ O_2 ☐ O^2 ☐ 2O ☐

4.4.1.3 Extraction of metals and reduction

Question 51 · continued

0 5 . 3 Aluminium oxide contains the ions Al^{3+} and O^{2-}

Explain why aluminium is produced at the **negative** electrode.

[2 marks]

0 5 . 4 The melting point of aluminium oxide is 2045 °C.

The melting point of the mixture of aluminium oxide and cryolite is 950 °C.

Explain why the electrolysis uses the mixture instead of pure aluminium oxide.

[2 marks]

0 5 . 5 The positive electrodes in the electrolysis cell are made of carbon.

Why do the positive electrodes need to be continually replaced?

[1 mark]

Tick (✓) **one** box.

Carbon reacts with the aluminium oxide. ☐

Carbon reacts with the aluminium produced. ☐

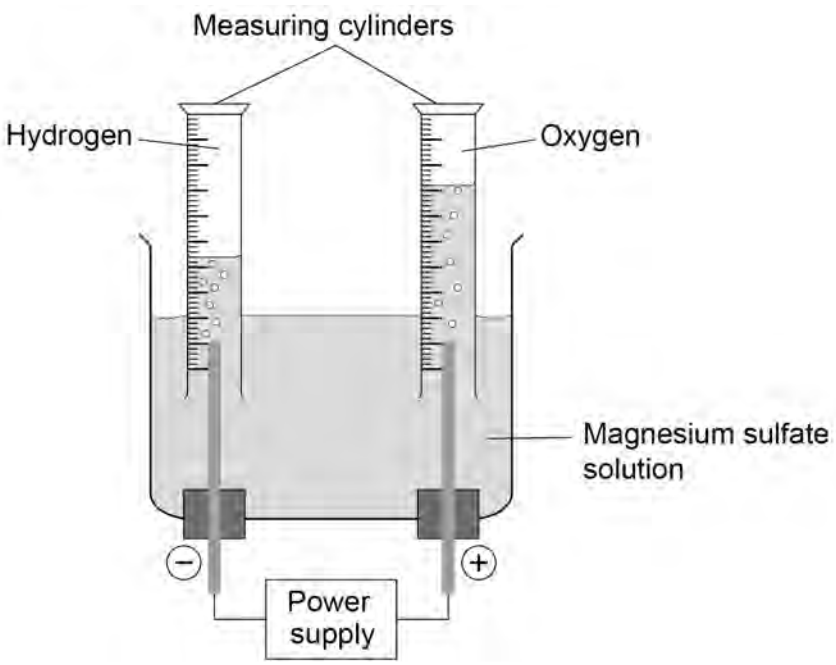
Carbon reacts with the oxygen produced. ☐

Question 51 · continued

A student investigated the electrolysis of magnesium sulfate solution.

Figure 5 shows the apparatus.

Figure 5



This is the method used.

1. Set the power supply to give a current of 0.05 A.

2. Measure the volume of each gas every minute for 5 minutes.

3. Repeat steps 1 and 2 using a current of 0.10 A in step 1.

4.4.1.3 Extraction of metals and reduction

Question 51 · continued

0 5 . 6 **Figure 6** shows a measuring cylinder during the electrolysis.

Figure 6



What is the volume of gas in the measuring cylinder?

[1 mark]

Tick (✓) **one** box.

2.7 cm^3 ☐ 3.4 cm^3 ☐ 4.6 cm^3 ☐

0 5 . 7 Hydrogen is produced instead of magnesium at the negative electrode.

Why is hydrogen produced at the negative electrode?

[1 mark]

Tick (✓) **one** box.

Hydrogen is less reactive than magnesium. ☐

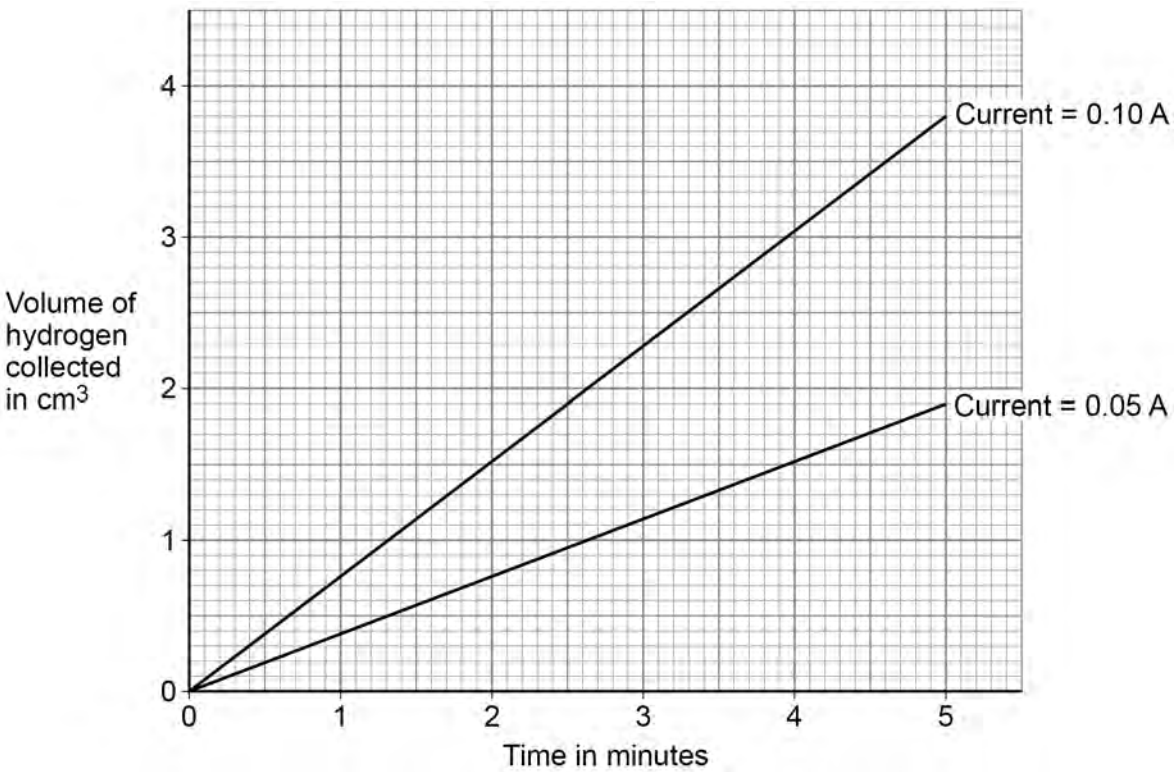
Hydrogen has the same reactivity as magnesium. ☐

Hydrogen is more reactive than magnesium. ☐

Question 51 · continued

0 5 . 8 **Figure 7** shows the results for the volume of hydrogen collected.

Figure 7



Which hypothesis explains the results in **Figure 7**?

[1 mark]

Tick (✓) **one** box.

The volume of hydrogen collected depends on **both** the current and the time. ☐

The volume of hydrogen collected depends on the current but **not** the time. ☐

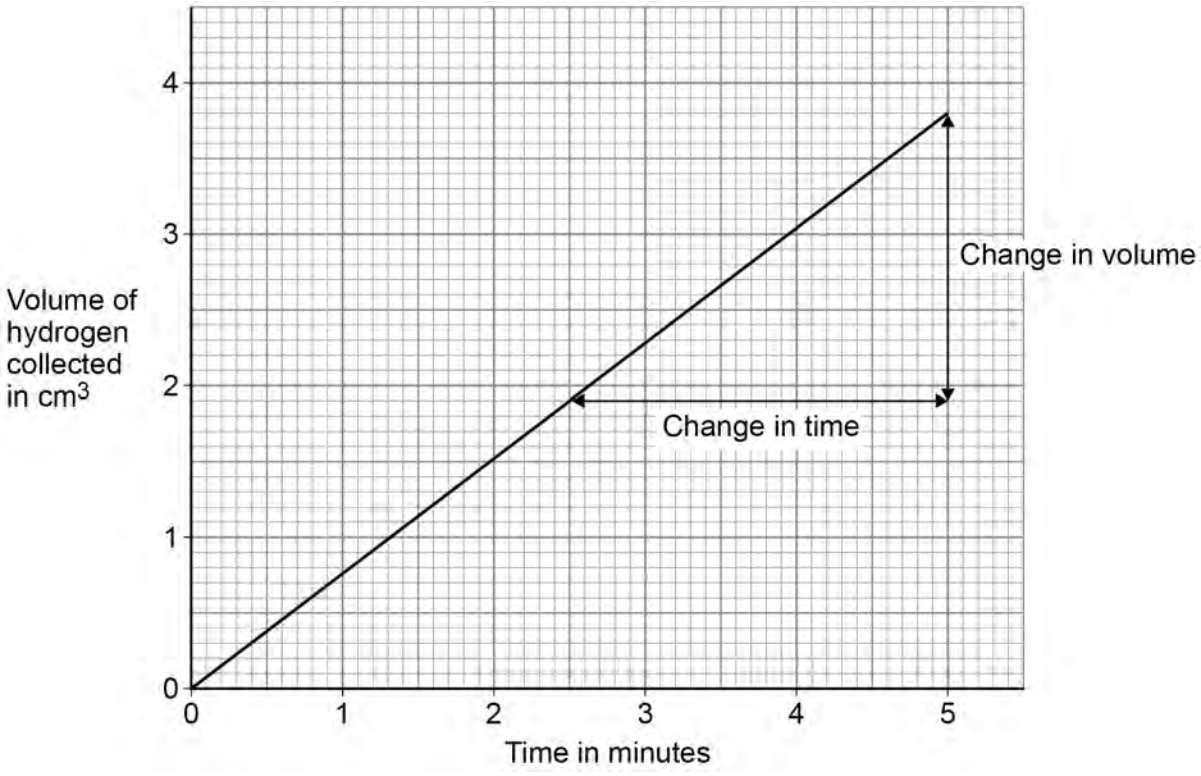
The volume of hydrogen collected depends on the time but **not** the current. ☐

4.4.1.3 Extraction of metals and reduction

Question 51 · continued

0 5 . 9 **Figure 8** is a repeat of part of the graph for current = 0.10 A in **Figure 7**.

Figure 8



Determine the gradient of the graph in **Figure 8**.

Use the equation

$$\text{gradient} = \frac{\text{change in volume}}{\text{change in time}}$$

[4 marks]

Change in volume = _____ cm^3

Change in time = _____ min

Gradient = _____ cm^3/min

15

4.4.1.3 Extraction of metals and reduction

Question 52

June 2025 | 8462/1F | Original Q10

1 0 This question is about metals and metal oxides.

Tin (Sn) is extracted from tin oxide using carbon.

The equation for the reaction is:

$$SnO_2 + C \longrightarrow Sn + CO_2$$

1 0 . 1 Which substance is reduced in this reaction?

Give **one** reason for your answer.

Answer in terms of oxygen.

[2 marks]

Substance reduced _____

Reason _____

_____

1 0 . 2 Why can carbon be used to extract tin from tin oxide?

[1 mark]

_____

_____

Question 10 continues on the next page

Question 52 · continued

10.3 Cadmium (Cd) can be extracted by the reaction of cadmium oxide with carbon.

The equation for the reaction is:

$$CdO + C \longrightarrow Cd + CO$$

Calculate the percentage atom economy for the production of cadmium in this reaction.

Relative atomic masses (A_r): C = 12 Cd = 112

Relative formula mass (M_r): CdO = 128

[3 marks]

Percentage atom economy = _____ %

10.4 Tungsten is a transition metal.

Potassium is a Group 1 metal.

Give **two** differences between the properties of tungsten and the properties of potassium.

[2 marks]

1 _____

2 _____

4.4.1.3 Extraction of metals and reduction

Question 52 · continued

Tungsten oxide reacts with hydrogen to give tungsten (W) and water.

10.5 The equation for the reaction is:

$$WO_3 + 3\,H_2 \longrightarrow W + 3\,H_2O$$

The law of conservation of mass states:

'The mass of the products equals the mass of the reactants during a chemical reaction.'

Show that the equation obeys the law of conservation of mass.

Relative atomic mass (A_r): W = 184

Relative formula masses (M_r): H_2 = 2 WO_3 = 232 H_2O = 18

[2 marks]

10.6 The reaction producing tungsten has a high atom economy.

Why is it important to use reactions with a high atom economy in industry?

[1 mark]

11