AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.1.1

Metal oxides

Past-paper questions

Tier	**Foundation**
Question groups	**42**
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.

4.4.1.1 Metal oxides

Question 01

June 2007 | CHY1A | Original Q1 | Legacy

QUESTION ONE

The balanced, symbol equation shows the atoms involved in a chemical reaction.

$Fe_2O_3(s)$	+	$3CO(g)$	→	$2Fe(s)$	+	$3CO_2(g)$
iron oxide		carbon monoxide		iron		carbon dioxide

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

A atom

B compound

C element

D symbol

O is the . . . **1** . . . for oxygen.

Fe_2O_3 is the formula for the . . . **2** . . . , iron oxide.

Fe represents one . . . **3** . . . of iron.

Carbon is a soft, black, non-metal . . . **4** . . . .

4.4.1.1 Metal oxides

Question 02

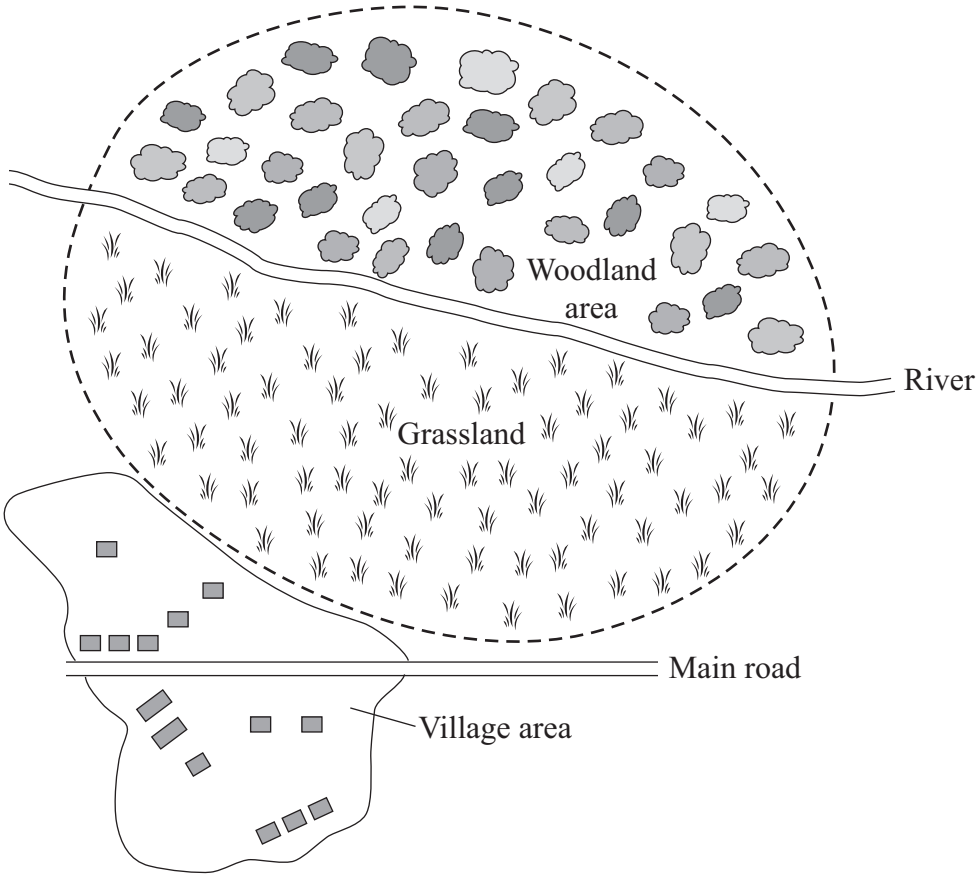
June 2007 | CHY1F | Original Q4 | Legacy

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 02 · 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.

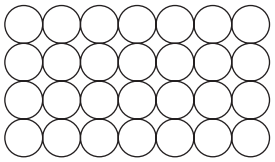
(i) Iron is extracted from its oxide in the blast furnace.

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)

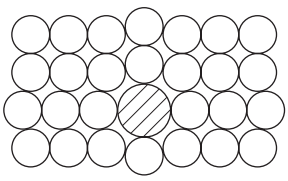
Question 4 continues on the next page

4.4.1.1 Metal oxides

Question 02 · 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

4.4.1.1 Metal oxides

Question 03

June 2007 | CHY1F | Original Q7 | Legacy

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.

.....

.....

.....

.....

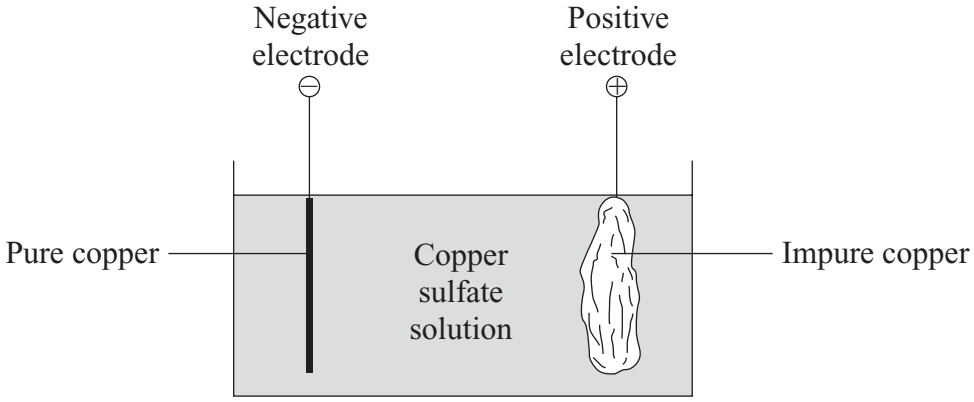
(2 marks)

4.4.1.1 Metal oxides

Question 03 · 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

4.4.1.1 Metal oxides

Question 04

January 2008 | CHY2F | Original Q3 | Legacy

3 Distress flares are used to attract attention in an emergency.



Flares often contain magnesium. Magnesium burns to form magnesium oxide.

(a) The distress flare burns with a bright flame because the reaction is very *exothermic*.

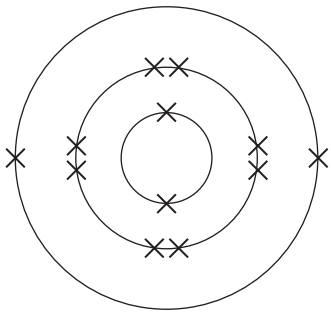
Complete the following sentence using the correct words from the box.

gives out heat	**stores heat**	**takes in heat**

An *exothermic* reaction is one which ..... .

(1 mark)

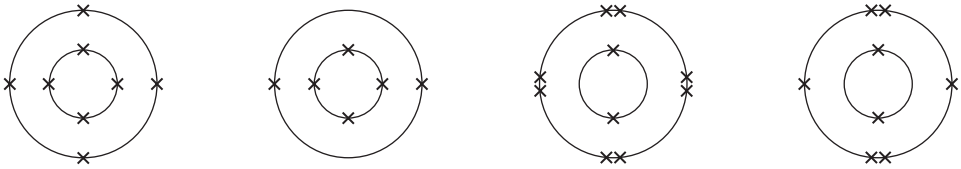
(b) The diagram shows the electronic structure of a magnesium atom.
The atomic (proton) number of magnesium is 12.



Magnesium atom

The atomic (proton) number of oxygen is 8.

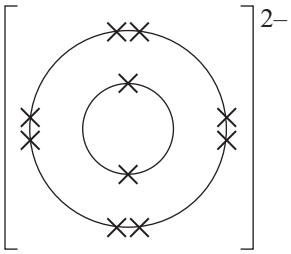
Which diagram, **A**, **B**, **C** or **D**, shows the electronic structure of an oxygen atom?



A **B** **C** **D**

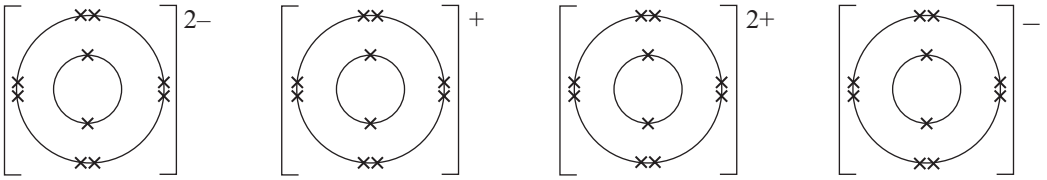
Diagram .....
(1 mark)

(c) Magnesium ions and oxide ions are formed when magnesium reacts with oxygen. The diagram shows the electronic structure of an oxide ion.



Oxide ion

Which diagram, **J**, **K**, **L** or **M**, shows the electronic structure of a magnesium ion?



J **K** **L** **M**

Diagram .....
(1 mark)

(d) Indigestion tablets can be made from magnesium oxide. The magnesium oxide neutralises some of the hydrochloric acid in the stomach.

Draw a ring around the name of the salt formed when magnesium oxide reacts with hydrochloric acid.

magnesium chloride **magnesium hydroxide** **magnesium sulfate**

(1 mark)

4

4.4.1.1 Metal oxides

Question 05

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** . . . .

4.4.1.1 Metal oxides

Question 06

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.

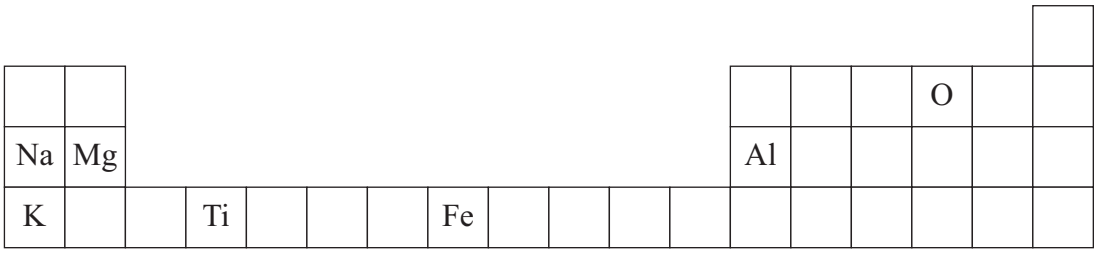
4.4.1.1 Metal oxides

Question 07

March 2010 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

This is part of the periodic table.



8A What do the metals Fe (iron) and Ti (titanium) have in common?

1 They belong to the same group in the periodic table.

2 They are transition metals.

3 They do **not** conduct electricity.

4 They are resistant to corrosion.

8B When Fe (iron) and O (oxygen) react, iron atoms join with oxygen atoms to form iron oxide, Fe_2O_3

When this happens, . . .

1 the nuclei from iron and oxygen atoms join together.

2 electrons are lost and new atoms form.

3 electrons are transferred and chemical bonds hold the atoms together.

4 the nuclei are transferred and new atoms form.

8C Fe (iron) and O (oxygen) are in the periodic table but Fe_2O_3 (iron oxide) is not.

This is because iron oxide is . . .

1 an alloy.

2 a compound.

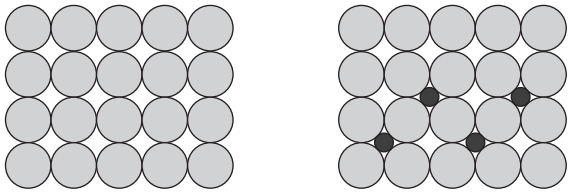
3 an ore.

4 a gas.

4.4.1.1 Metal oxides

Question 07 · continued March 2010 | CHY1AP | Original Q8 | Legacy

8D The diagram shows the arrangement of atoms in pure iron and in steel.



Pure iron **Steel**

Which row in the table shows the metal that is harder **and** correctly explains why it is harder?

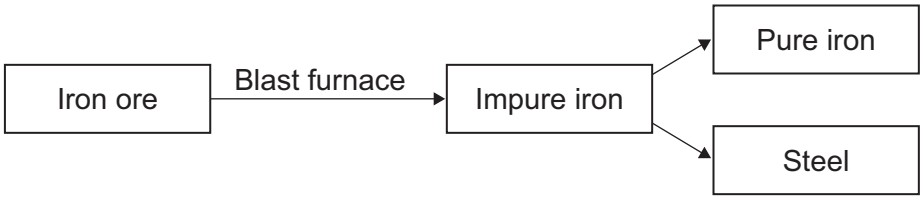
	Harder metal	Explanation
1	Pure iron	It contains only one type of atom.
2	Steel	The atoms cannot easily slide over each other.
3	Pure iron	The atoms cannot easily slide over each other.
4	Steel	It contains only one type of atom.

4.4.1.1 Metal oxides

Question 08 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.

4.4.1.1 Metal oxides

Question 09

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.

4.4.1.1 Metal oxides

Question 10

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

4.4.1.1 Metal oxides

Question 11

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.

.....

.....

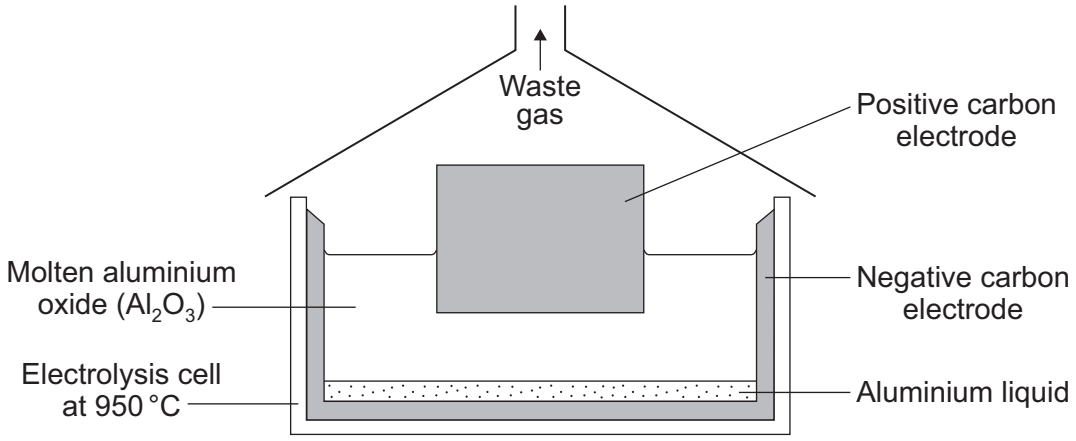
.....

(1 mark)

4.4.1.1 Metal oxides

Question 11 · 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

4.4.1.1 Metal oxides

Question 12

7 Calamine lotion is used to treat itching. The main ingredients are two metal oxides.



7 (a) One of the metal oxides has a relative formula mass (M_r) of 81.

The formula of this metal oxide is MO.
(M is **not** the correct symbol for the metal.)

The relative atomic mass (A_r) of oxygen is 16.

7 (a) (i) Calculate the relative atomic mass (A_r) of metal M.

.....

.....

.....

Relative atomic mass (A_r) = ...
(2 marks)

7 (a) (ii) Use your answer to part (a)(i) and the periodic table on the Data Sheet to name metal M.

The name of metal M is ..... .
(1 mark)

4.4.1.1 Metal oxides

Question 12 · continued

7 (b) The other metal oxide is iron(III) oxide.

This contains iron(III) ions (Fe^{3+}) and oxide ions (O^{2-}).

7 (b) (i) Explain in terms of electrons how an iron atom (Fe) can change into an iron(III) ion (Fe^{3+}).

.....

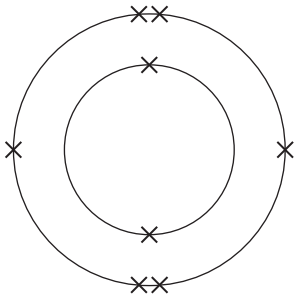
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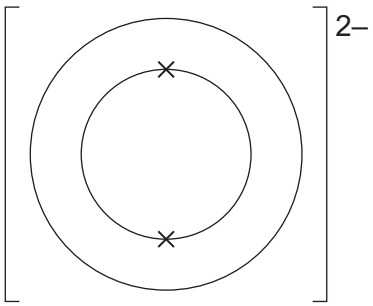
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(2 marks)

7 (b) (ii) The diagram below represents the electronic structure of an oxygen atom (O).



Complete the diagram below to show the electronic structure of an oxide ion (O^{2-}).



(1 mark)

6

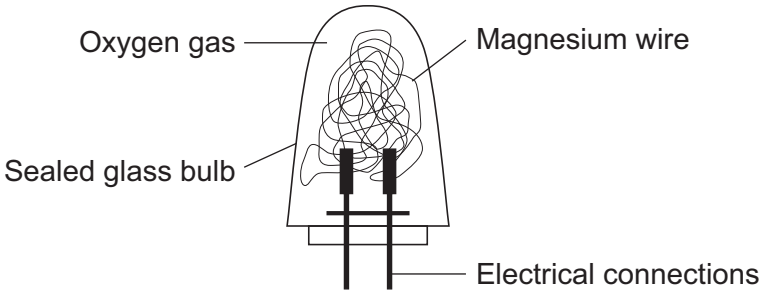
4.4.1.1 Metal oxides

Question 13

March 2011 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

The diagram shows a flash bulb that was used in photography.



When a photograph is taken, an electric current flows through the magnesium. The magnesium burns very brightly and very quickly. A white powder called magnesium oxide (MgO) is formed.

A student wanted to find out if the mass of the flash bulb changed when it was used.

- The mass of a new flash bulb was measured.
- It was made to flash and then allowed to cool.
- The glass bulb was unbroken.
- The mass of the used flash bulb was then measured.

8A Which of the following statements is correct?

The mass of the flash bulb . . .

1 did not change.

2 changed because a chemical reaction had taken place.

3 increased because a new substance had been made.

4 decreased because the magnesium and oxygen had been used up.

8B Which statement correctly describes what happens inside the flash bulb?

1 Magnesium and oxygen atoms make magnesium oxide when they mix together.

2 Magnesium and oxygen atoms combine and are held together by chemical bonds.

3 Many new magnesium and oxygen atoms are formed when there is a flash inside the flash bulb.

4 Magnesium and oxygen atoms combine to make atoms of magnesium oxide.

4.4.1.1 Metal oxides

Question 13 · continued

8C Which row in the table gives a correct description of each substance involved in the reaction in the flash bulb?

	Substance		
	Magnesium	**Oxygen**	**Magnesium oxide**
1	element	element	compound
2	element	compound	element
3	compound	compound	element
4	element	compound	compound

8D The magnesium oxide made in this reaction can be used to produce magnesium nitrate. The formula for magnesium nitrate is $Mg(NO_3)_2$

Which row in the table below shows the numbers of each type of atom in the formula $Mg(NO_3)_2$?

	Magnesium	**Nitrogen**	**Oxygen**
1	1	1	3
2	2	1	6
3	1	2	3
4	1	2	6

4.4.1.1 Metal oxides

Question 14

QUESTION FIVE

A mixture of iron oxide and aluminium reacts when heated.

This is the balanced equation for the reaction:

$$Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe$$

Symbols	
Fe	Iron
O	Oxygen
Al	Aluminium

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

A electrons

B bonds

C products

D elements

Iron oxide and aluminium are the reactants. Aluminium oxide and iron are the . . . **1** . . . .

Aluminium atoms and oxygen atoms combine by transferring . . . **2** . . . .

The particles (ions) in aluminium oxide are held together by . . . **3** . . . .

The equation is balanced because, in the reaction, there is no change in the total number of atoms of each of the . . . **4** . . . .

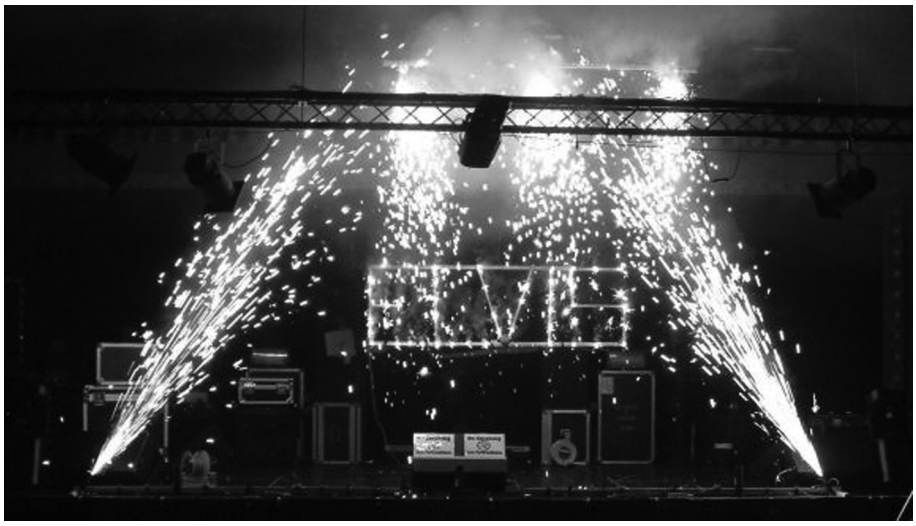
4.4.1.1 Metal oxides

Question 15

June 2011 | CHY2F | Original Q5 | Legacy

5 Read the information in the box.

Flash powder is used to produce special effects at pop concerts.



Flash powder contains aluminium. The powder burns with a bright white flame and gives out lots of heat and light. It also produces white smoke.

The flash powder is placed on stage in a special container. At the bottom of the container there is a thin piece of wire. When the flash is needed, electricity is passed through the wire. The wire gets hot and starts the aluminium burning.

5 (a) When aluminium burns the reaction is exothermic.

Give **one** piece of information from the box which shows that the reaction is exothermic.

.....

(1 mark)

5 (b) The hot wire provides energy to start the aluminium burning.

Draw a ring around the name given to the energy needed to start a chemical reaction.

activation energy **potential energy** **solar energy**

(1 mark)

5 (c) When aluminium burns it reacts with oxygen to make aluminium oxide.

Complete the word equation for this reaction.

aluminium + ... → .....

(1 mark)

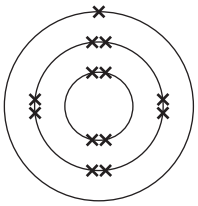
4.4.1.1 Metal oxides

Question 15 · continued

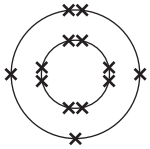
5 (d) An aluminium atom has 13 electrons.

Which diagram, **A, B** or **C**, represents the electronic structure of an aluminium atom?

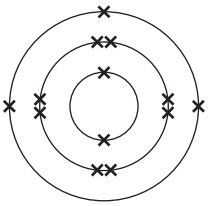
A



B



C



The electronic structure of an aluminium atom is diagram ☐

(1 mark)

5 (e) The white smoke produced is aluminium oxide.

Aluminium oxide contains aluminium ions (Al^{3+}) and oxide ions (O^{2-}).

Draw a ring around the correct word in each box to complete each sentence.

5 (e) (i) Electrons have [a negative / no / a positive] charge.

(1 mark)

5 (e) (ii) When an aluminium atom (Al) turns into an aluminium ion (Al^{3+})

it [gains / loses / shares] three electrons.

(1 mark)

5 (e) (iii) When an oxygen atom (O) turns into an oxide ion (O^{2-})

it [gains / loses / shares] [one / two / three] electrons.

(2 marks)

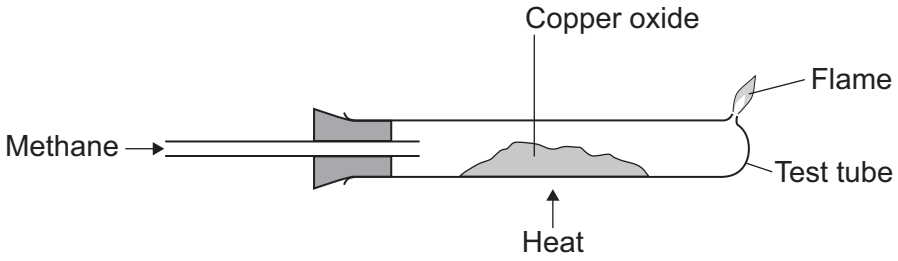
8

4.4.1.1 Metal oxides

Question 16

June 2011 | CHY2F | Original Q7 | Legacy

7 An experiment was done on the reaction of copper oxide (CuO) with methane (CH_4).



7 (a) The equation for this reaction is shown below.

$$4CuO(s) + CH_4(g) \rightarrow 4Cu(s) + 2H_2O(g) + CO_2(g)$$

The water and carbon dioxide produced escapes from the test tube.

Use information from the equation to explain why.

.....

(1 mark)

7 (b) (i) Calculate the relative formula mass (M_r) of copper oxide (CuO).

Relative atomic masses (A_r): O = 16; Cu = 64.

.....

.....

.....

Relative formula mass (M_r) = ...

(2 marks)

7 (b) (ii) Calculate the percentage of copper in copper oxide.

.....

.....

.....

Percentage of copper = ... %

(2 marks)

4.4.1.1 Metal oxides

Question 16 · continued

7 (b) (iii) Calculate the mass of copper that could be made from 4.0 g of copper oxide.

.....

.....

Mass of copper = ... g

(1 mark)

7 (c) The experiment was done three times.
The mass of copper oxide used and the mass of copper made was measured each time.
The results are shown in the table.

	Experiment		
	1	**2**	**3**
Mass of copper oxide used in g	4.0	4.0	4.0
Mass of copper made in g	3.3	3.5	3.2

7 (c) (i) Calculate the mean mass of copper made in these experiments.

.....

.....

Mean mass of copper made = ... g

(1 mark)

7 (c) (ii) Suggest how the results of these experiments could be made more precise.

.....

.....

(1 mark)

7 (c) (iii) The three experiments gave slightly different results for the mass of copper made.
This was caused by experimental error.

Suggest **two** causes of experimental error in these experiments.

1 .....

.....

2 .....

.....

(2 marks)

10

4.4.1.1 Metal oxides

Question 17

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.

4.4.1.1 Metal oxides

Question 17 · 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

4.4.1.1 Metal oxides

Question 18

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.

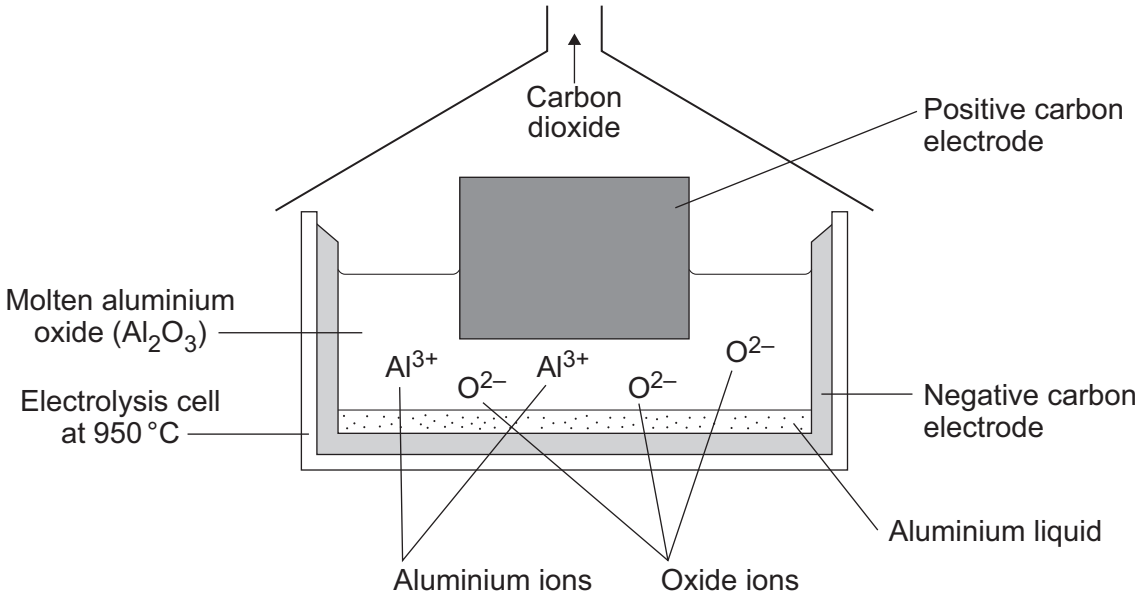
Why does aluminium oxide **not** react with carbon?

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.



4.4.1.1 Metal oxides

Question 18 · 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)

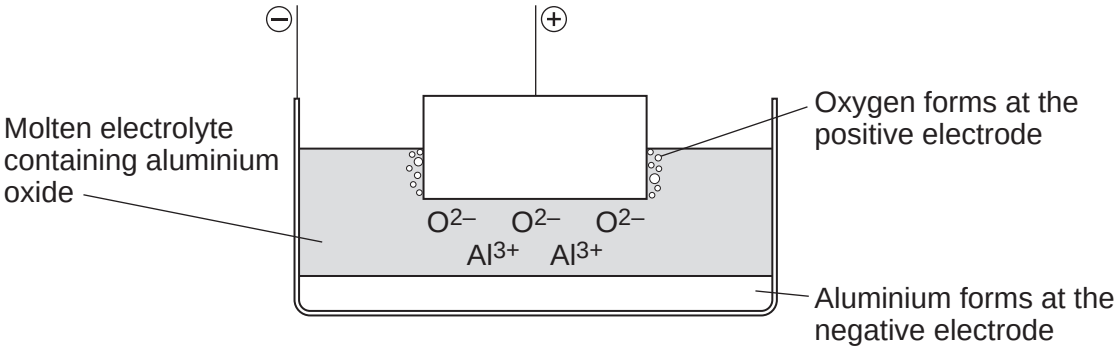
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4.4.1.1 Metal oxides

Question 19

June 2012 | CH2FP | Original Q4 | Legacy

4 The diagram represents an electrolysis cell for extracting aluminium.
The current will only flow when the electrolyte is molten.



4 (a) The electrolyte is aluminium oxide mixed with another substance.

4 (a) (i) What is the name of the other substance in the electrolyte?

Draw a ring around the correct answer.

cryolite **rock salt** **limestone**

(1 mark)

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

This other substance is added to

condense the aluminium oxide.
lower the melting point of the aluminium oxide.
raise the boiling point of the aluminium oxide.

(1 mark)

4 (b) (i) Oxide ions (O^{2-}) move to the positive electrode.

Explain why.

.....

.....

.....

.....

(2 marks)

4.4.1.1 Metal oxides

Question 19 · continued

4 (b) (ii) Oxygen is formed at the positive electrode. The oxygen then forms carbon dioxide.

The equation for the reaction is shown below.

$$C + O_2 \rightarrow CO_2$$

Complete the sentence.

The name of the element which reacts with oxygen is ..... .

(1 mark)

4 (b) (iii) The positive electrode gets smaller.

Suggest why.

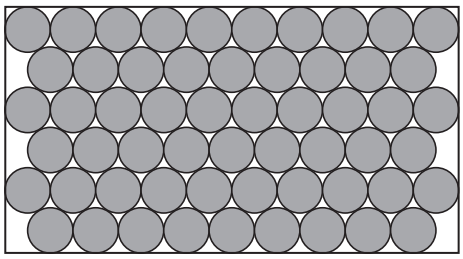
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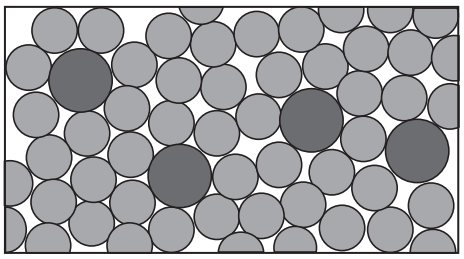
(1 mark)

4 (c) Aluminium is used in an alloy with magnesium to make drinks cans.

The diagrams show the arrangement of atoms in pure aluminium and in the alloy.



Pure aluminium



Alloy

The alloy is harder than pure aluminium.

Explain why. Use the diagrams to help you.

.....

.....

.....

.....

(2 marks)

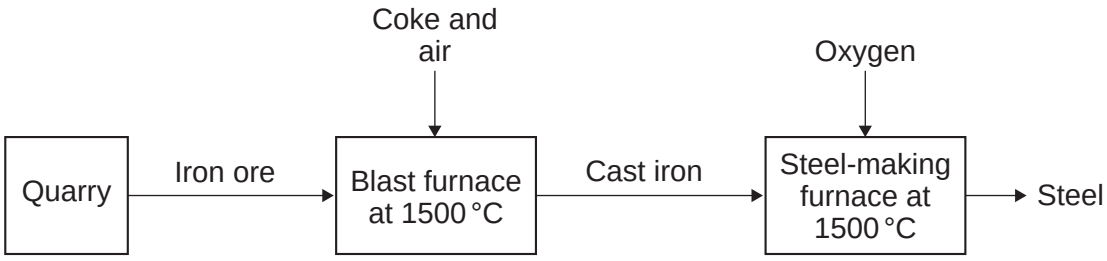
8

4.4.1.1 Metal oxides

Question 20

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)

4.4.1.1 Metal oxides

Question 20 · continued January 2013 | CH1FP | Original Q4 | Legacy

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

4.4.1.1 Metal oxides

Question 20 · 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

4.4.1.1 Metal oxides

Question 21

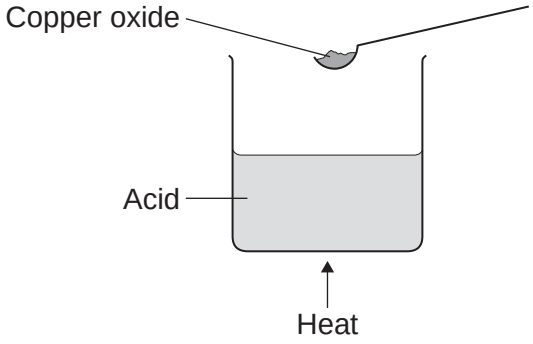
January 2013 | CH2FP | Original Q5 | Legacy

5 A student added copper oxide to an acid to make copper sulfate.

The student heated the acid.

The student added copper oxide until no more reacted.

5 (a) The diagram shows the first stage in the experiment.



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

Copper oxide + ... acid → copper sulfate + water

(1 mark)

5 (a) (ii) Which **one** of these values could be the pH of the acid?

Draw a ring around the correct answer.

1 **7** **11**

(1 mark)

5 (a) (iii) Why is the acid heated?

.....

.....

(1 mark)

5 (b) After the reaction is complete, some solid copper oxide remains.
Why?

.....

.....

(1 mark)

4.4.1.1 Metal oxides

Question 21 · continued

5 (c) The student removed the solid copper oxide from the solution.

Suggest what the student should do to the solution to form copper sulfate crystals.

.....

.....

(1 mark)

5 (d) The mass of copper sulfate crystals was less than the student expected.

Tick (✓) the **one** statement that explains why the mass of copper sulfate crystals was less than expected.

Statement	Tick (✓)
Some copper sulfate may have been lost during the experiment.	
The student added too much copper oxide.	
The copper sulfate crystals were wet when they were weighed.	

(1 mark)

6

4.4.1.1 Metal oxides

Question 22

June 2013 | CH1FP | Original Q1 | Legacy

1 Magnesium burns in oxygen.



1 (a) Use the Chemistry Data Sheet to help you to answer this question.

The word equation for magnesium burning is:

magnesium + oxygen ⟶ magnesium oxide

Draw **one** line from each substance to its correct description.

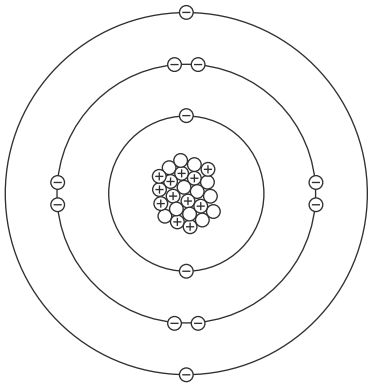
Substance	Description
magnesium	compound
magnesium oxide	metal
oxygen	mixture
	non-metal

(3 marks)

4.4.1.1 Metal oxides

Question 22 · continued

1 (b) The diagram represents a magnesium atom.



Complete the table to show the name of each particle and the charge of each particle in the magnesium atom.

Name of particle	Charge
proton	+1
neutron	.....
.....	–1

(2 marks)

1 (c) Use the Chemistry Data Sheet to help you to answer these questions.

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

1 (c) (i) In a magnesium atom, the protons and neutrons are in the

core.
nucleus.
shell.

(1 mark)

1 (c) (ii) The number of protons in a magnesium atom is the

atomic number.
mass number.
group number.

(1 mark)

1 (c) (iii) The sum of the protons and neutrons in a magnesium atom is the

atomic number.
mass number.
group number.

(1 mark)

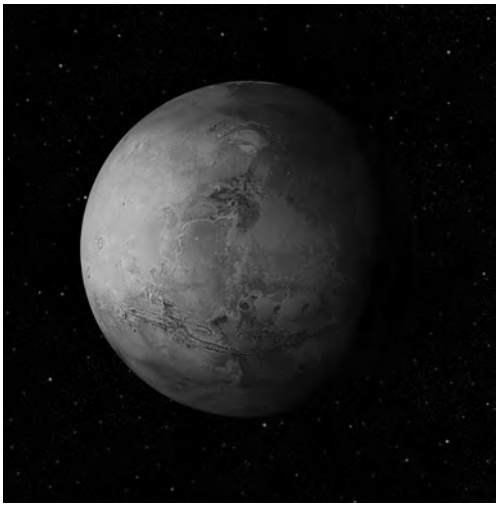
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4.4.1.1 Metal oxides

Question 23

June 2013 | CH2FP | Original Q5 | Legacy

5 This question is about the planet Mars.



5 (a) Mars is a red colour in the sky at night.

The red colour of Mars is because of iron oxide.

Iron oxide is an ionic compound.

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

Ionic compounds are made of

- giant lattices.
- polymer chains.
- simple molecules.

(1 mark)

5 (b) Many spacecraft have been sent to Mars. Parts of these spacecraft are made from polymers.

5 (b) (i) Polymers that behave like shape memory alloys are used in spacecraft.

The shape memory polymers are cooled and compressed. These polymers are stored on the spacecraft until needed.

Suggest how the polymers could be made to return to their original shape.

.....

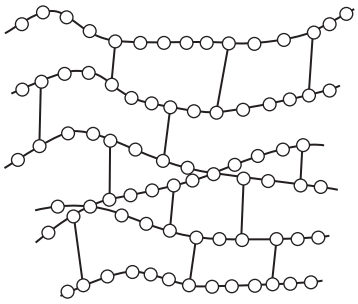
(1 mark)

4.4.1.1 Metal oxides

Question 23 · continued

5 (b) (ii) Thermosetting polymers are used for the tiles on the outside of spacecraft.

The diagram shows the structure of a thermosetting polymer.



Explain, in terms of structure, why some polymers are thermosetting.

.....

.....

.....

.....

(2 marks)

5 (c) Instrumental methods such as GC–MS are used to analyse substances found on Mars.

In GC–MS, gas chromatography columns are linked to mass spectrometers.

5 (c) (i) What does gas chromatography do to the substances?

.....

.....

(1 mark)

5 (c) (ii) Give **two** reasons for using instrumental methods for analysis.

1 .....

.....

2 .....

.....

(2 marks)

7

4.4.1.1 Metal oxides

Question 24

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.

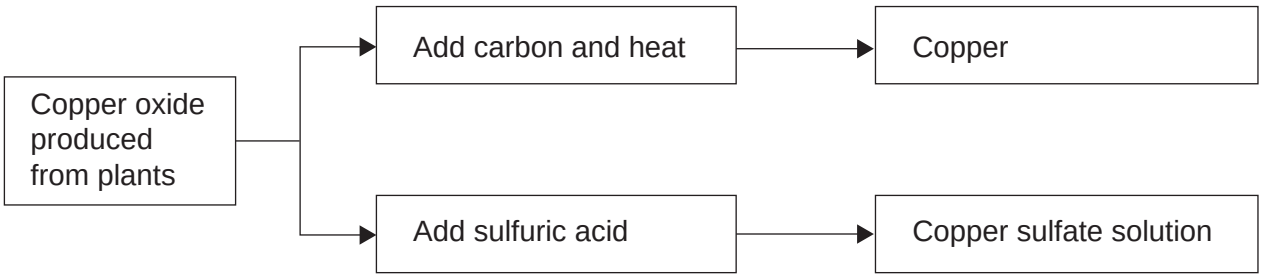
One way to extract the copper is to grow plants on the land.

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]

4.4.1.1 Metal oxides

Question 24 · continued

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

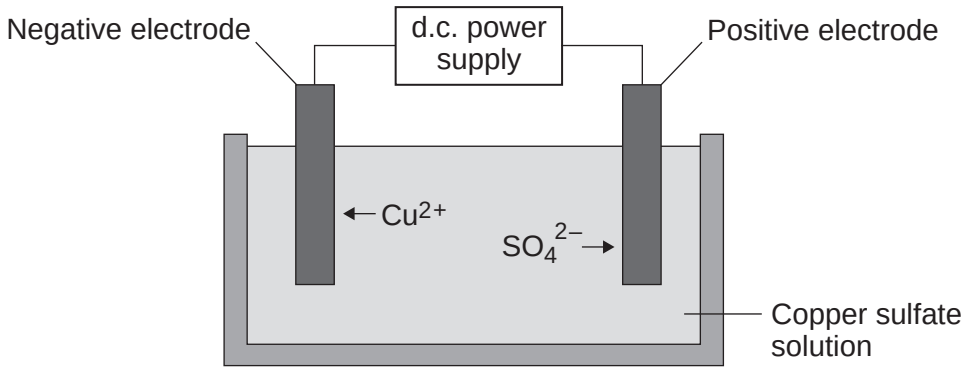
5 (b) (i) Complete the word equation.

[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

4.4.1.1 Metal oxides

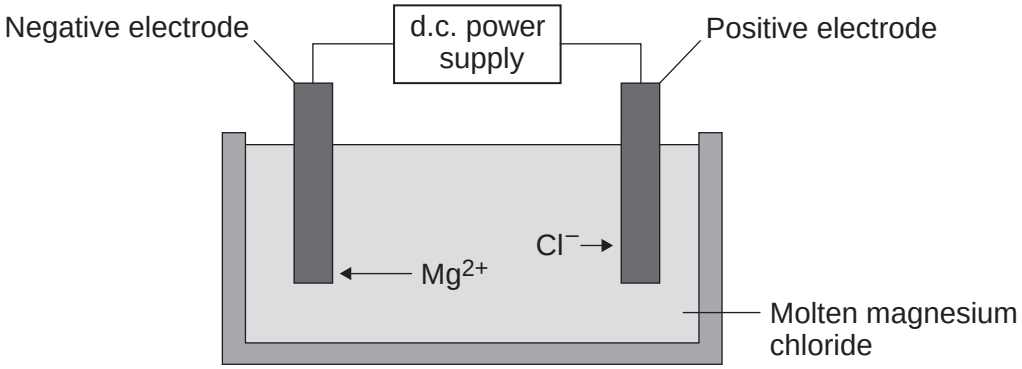
Question 25

June 2014 | CH2FP | Original Q5 | Legacy

5 Some students investigated reactions to produce magnesium.

5 (a) The students used electrolysis to produce magnesium from magnesium chloride, as shown in **Figure 7**.

Figure 7



5 (a) (i) Magnesium chloride contains magnesium ions and chloride ions.

Why does solid magnesium chloride **not** conduct electricity?

[1 mark]

.....

.....

5 (a) (ii) One of the products of the electrolysis of molten magnesium chloride is magnesium.

Name the other product.

[1 mark]

.....

5 (a) (iii) Why do magnesium ions (Mg^{2+}) move to the negative electrode?

[1 mark]

.....

.....

4.4.1.1 Metal oxides

Question 25 · continued

5 (a) (iv) At the negative electrode, the magnesium ions (Mg^{2+}) gain electrons to become magnesium atoms.

How many electrons does each magnesium ion gain?

[1 mark]

.....

5 (b) The students did the experiment four times and weighed the magnesium produced.

Table 1 shows their results.

Table 1

Experiment	Mass of magnesium produced in grams
1	1.13
2	0.63
3	1.11
4	1.09

5 (b) (i) There is an anomalous result.

Suggest **one** possible reason for the anomalous result.

[1 mark]

.....

.....

5 (b) (ii) Calculate the mean mass of magnesium produced, taking account of the anomalous result.

[2 marks]

.....

.....

.....

Mean mass = ... g

4.4.1.1 Metal oxides

Question 25 · continued

5 (c) The formula of magnesium chloride is $MgCl_2$

The relative formula mass of magnesium chloride is 95.

The relative atomic mass of magnesium is 24.

5 (c) (i) Use the equation to calculate the percentage mass of magnesium in magnesium chloride.

$$\text{Percentage mass of magnesium} = \frac{\text{mass of magnesium}}{\text{mass of magnesium chloride}} \times 100\%$$

[2 marks]

.....

.....

.....

Percentage mass of magnesium in magnesium chloride = ... %

5 (c) (ii) Draw a ring around the relative mass of chlorine in $MgCl_2$

[1 mark]

71 **95** **119**

4.4.1.1 Metal oxides

Question 25 · continued

5 (d) Magnesium is also produced from the reaction of magnesium oxide with silicon.

5 (d) (i) The equation for the reaction is:

$$2\ MgO(s) + Si(s) \rightleftharpoons SiO_2(s) + 2\ Mg(s)$$

What is the meaning of this symbol $\rightleftharpoons$?

Draw a ring around the correct answer.

[1 mark]

neutralisation reaction **precipitation reaction** **reversible reaction**

5 (d) (ii) The forward reaction is endothermic.

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

[1 mark]

In an endothermic reaction the temperature of the surroundings

decreases.

increases.

stays the same.

12

4.4.1.1 Metal oxides

Question 26

June 2015 | CH2FP | Original Q4 | Legacy

4 This question is about electrolysis.

4 (a) Metal spoons can be coated with silver.
This is called electroplating.

Suggest **one** reason why spoons are electroplated.

[1 mark]

.....

.....

4 (b) When sodium chloride solution is electrolysed the products are hydrogen and chlorine.

4 (b) (i) What is made from chlorine?

[1 mark]

Tick (✓) **one** box.

Bleach ☐

Fertiliser ☐

Soap ☐

4 (b) (ii) Sodium chloride solution contains two types of positive ions, hydrogen ions (H^+) and sodium ions (Na^+).

Why is hydrogen produced at the negative electrode and **not** sodium?

[1 mark]

Tick (✓) **one** box.

Hydrogen is a gas. ☐

Hydrogen is less reactive than sodium. ☐

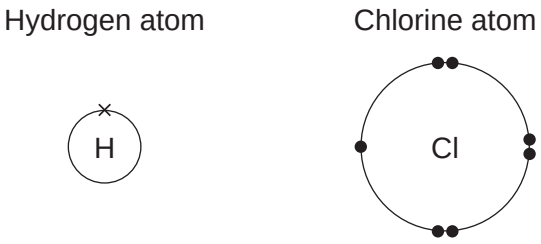
Hydrogen ions move faster than sodium ions. ☐

Question 26 · continued

4 (b) (iii) Hydrogen and chlorine can be used to produce hydrogen chloride.

The diagrams in **Figure 4** show how the outer electrons are arranged in an atom of hydrogen and an atom of chlorine.

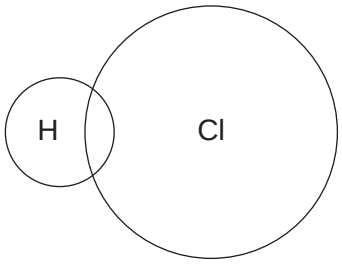
Figure 4



Complete **Figure 5** to show how the outer electrons are arranged in a molecule of hydrogen chloride (HCl).

[1 mark]

Figure 5



4 (b) (iv) What is the type of bond in a molecule of hydrogen chloride?

[1 mark]

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

Question 4 continues on the next page

4.4.1.1 Metal oxides

Question 26 · continued

4 (b) (v) Why is hydrogen chloride a gas at room temperature (20 °C)?

[2 marks]

Tick (✓) **two** boxes.

Hydrogen chloride has a low boiling point. ☐

Hydrogen chloride has a high melting point. ☐

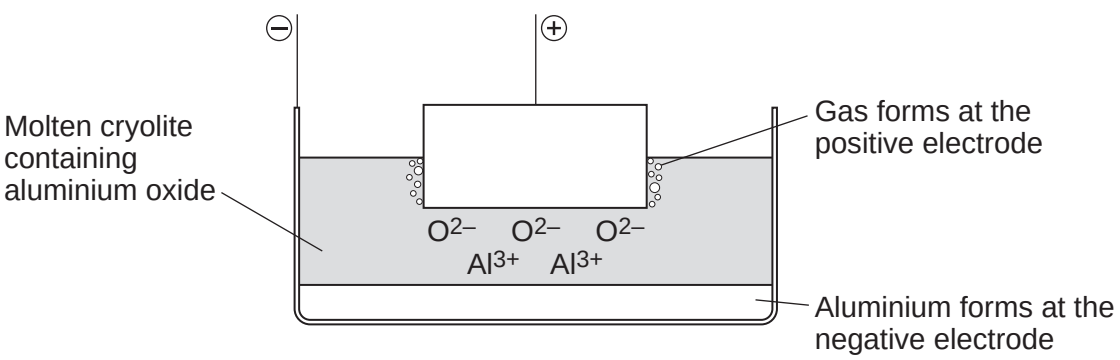
Hydrogen chloride is made of simple molecules. ☐

Hydrogen chloride does not conduct electricity. ☐

Hydrogen chloride has a giant structure. ☐

4 (c) Aluminium is produced by electrolysis of a molten mixture of aluminium oxide and cryolite.
This is shown in **Figure 6**.

Figure 6



4 (c) (i) Name a gas produced at the positive electrode.

[1 mark]

.....

4.4.1.1 Metal oxides

Question 26 · continued

4 (c) (ii) Aluminium ions move to the negative electrode.

Explain why.

[2 marks]

.....

.....

.....

.....

4 (c) (iii) At the negative electrode, the aluminium ions gain electrons to produce aluminium.

What is this type of reaction called?

[1 mark]

Tick (✓) **one** box.

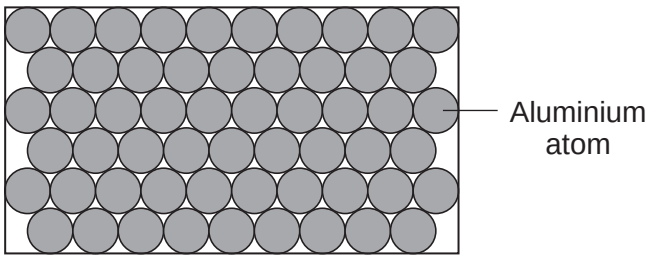
Combustion ☐

Oxidation ☐

Reduction ☐

4 (c) (iv) Aluminium has layers of atoms, as shown in **Figure 7**.

Figure 7



Complete the sentence.

[1 mark]

Metals can be bent and shaped because the layers of atoms can ..... .

Question 4 continues on the next page

4.4.1.1 Metal oxides

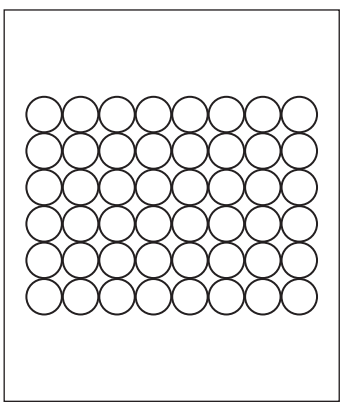
Question 26 · continued

4 (d) Electrodes used in the production of aluminium are made from graphite.

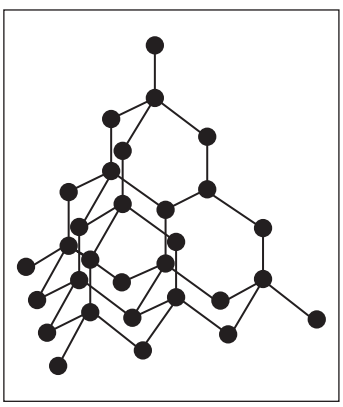
4 (d) (i) Which diagram, **A**, **B** or **C**, shows the structure of graphite?

[1 mark]

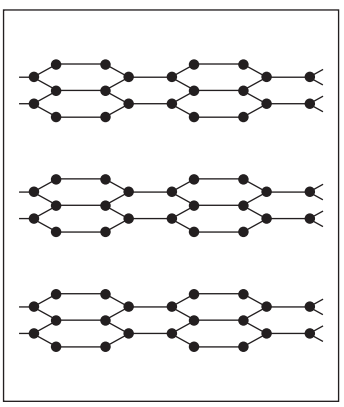
A



B



C



The structure of graphite is shown in diagram ☐.

4 (d) (ii) The temperature for the electrolysis is 950 °C.

Use the correct answer from the box to complete the sentence.

[1 mark]

cross links	**a giant ionic lattice**	**strong covalent bonds**

The graphite does not melt at 950 °C because

graphite has ..... .

14

4.4.1.1 Metal oxides

Question 27

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

4.4.1.1 Metal oxides

Question 28

June 2017 | CH2FP | Original Q2 | Legacy

2 This question is about sulfuric acid, copper sulfate and ethene.

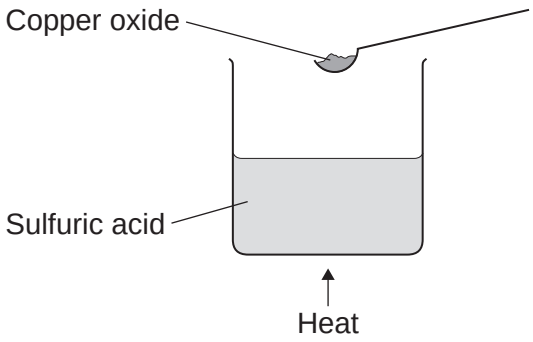
2 (a) A student added copper oxide to sulfuric acid to make copper sulfate.

The word equation for the reaction is:

sulfuric acid + copper oxide ⟶ copper sulfate + water

Figure 4 shows the first stage of the student's method.

Figure 4



2 (a) (i) The state symbol for CuO is missing from the equation below.

Use the correct answer from the box to complete the equation.

[1 mark]

aq	g	l	s

H_2SO_4 (aq) + CuO (___) ⟶ $CuSO_4$ (aq) + H_2O (l)

2 (a) (ii) Why is the sulfuric acid heated?

[1 mark]

_____

_____

Question 2 continues on the next page

4.4.1.1 Metal oxides

Question 28 · continued

2 (a) (iii) Which of these values could be the pH of sulfuric acid?

[1 mark]

Tick (✓) **one** box.

1 ☐

7 ☐

11 ☐

14 ☐

2 (a) (iv) Why does the student continue to add copper oxide until some is left at the end of the reaction?

[1 mark]

Tick (✓) **one** box.

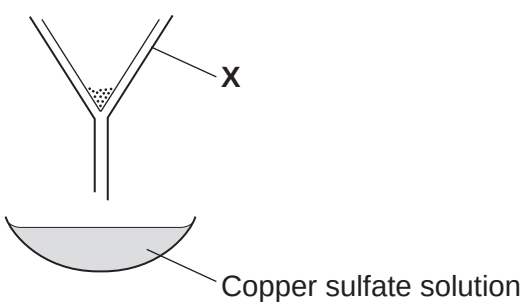
To make bigger copper sulfate crystals. ☐

To make sure all the copper oxide has reacted. ☐

To make sure all the sulfuric acid has reacted. ☐

2 (b) **Figure 5** shows the second stage of the student's method.

Figure 5



4.4.1.1 Metal oxides

Question 28 · continued

2 (b) (i) Name the apparatus labelled **X** on **Figure 5**.

[1 mark]

_____

2 (b) (ii) What could the student do to the copper sulfate solution to get copper sulfate crystals?

[1 mark]

_____

_____

2 (c) The student weighed the copper sulfate crystals.

Why was the mass of the copper sulfate crystals less than the student expected?

[1 mark]

Tick (✓) **one** box.

The student added too much copper oxide. ☐

The student left some copper sulfate crystals in the apparatus. ☐

The student weighed the copper sulfate crystals when they were wet. ☐

2 (d) The equation shows the reaction when blue hydrated copper sulfate crystals are heated.

hydrated copper sulfate $\rightleftharpoons$ anhydrous copper sulfate + water

2 (d) (i) What colour is anhydrous copper sulfate?

[1 mark]

_____

2 (d) (ii) What would you see if water is added to anhydrous copper sulfate?

[1 mark]

_____

4.4.1.1 Metal oxides

Question 28 · continued

2 (e) Ethene and sulfuric acid are used to make many substances.

Table 1 shows data about wealth of countries, ethene production and sulfuric acid production.

Table 1

Country	Wealth of country in billions of dollars	Ethene production in kilotonnes	Sulfuric acid production in kilotonnes
A	4000	13 900	36 000
B	1300	4 400	6 600
C	1290	2 700	26 000
D	460	1 500	2 500

2 (e) (i) Use the correct answer from the box to complete the sentence.

[1 mark]

alloys	chlorine	graphite	polymers

Ethene is used to make _____ .

2 (e) (ii) Describe the relationship, if any, between the wealth of a country and the production of ethene.

[1 mark]

_____

_____

2 (e) (iii) Describe the relationship, if any, between the wealth of a country and the production of sulfuric acid.

[1 mark]

_____

_____

12

4.4.1.1 Metal oxides

Question 29

June 2017 | CH2FP | Original Q3 | Legacy

3 This question is about oxygen and substances containing oxygen.

3 (a) Oxygen is a gas at room temperature.

3 (a) (i) What type of bonding holds the atoms together in oxygen?

[1 mark]

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

3 (a) (ii) Which **two** statements about oxygen are true?

[2 marks]

Tick (✓) **two** boxes.

Oxygen consists of a giant lattice. ☐

Oxygen consists of small molecules. ☐

Oxygen conducts electricity. ☐

Oxygen is an alloy. ☐

Oxygen has a low boiling point. ☐

Question 3 continues on the next page

4.4.1.1 Metal oxides

Question 29 · continued

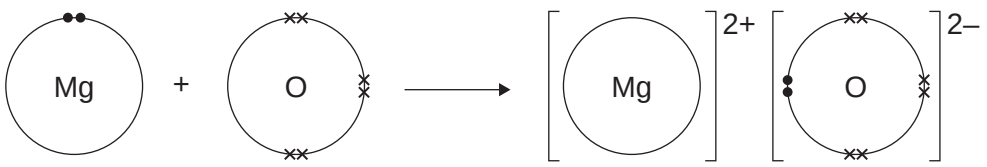
3 (b) Magnesium oxide is produced when magnesium reacts with oxygen.

3 (b) (i) **Figure 6** shows what happens to the electrons in the outer shells when a magnesium atom reacts with an oxygen atom.

The dots (•) and crosses (×) represent electrons.

Only the outer electrons are shown.

Figure 6



Describe, in terms of electrons, what happens when a magnesium atom reacts with an oxygen atom to produce magnesium oxide.

[4 marks]

4.4.1.1 Metal oxides

Question 29 · continued

3 (b) (ii) Nanoparticles of magnesium oxide can be made.

Which **two** statements about nanoparticles are true?

[2 marks]

Tick (✓) **two** boxes.

Nanoparticles are very small atoms. ☐

Nanoparticles can return to their original shape after being deformed. ☐

Nanoparticles contain a few hundred atoms. ☐

Nanoparticles contain millions of molecules. ☐

Nanoparticles have a high surface area to volume ratio. ☐

3 (c) Silicon dioxide has a very high melting point.

Silicon dioxide does not conduct electricity when molten.

Use the correct answer from the box to complete the sentence.

[1 mark]

giant covalent	giant ionic	metallic

The structure of silicon dioxide is _____ .

10

4.4.1.1 Metal oxides

Question 30

June 2018 | 8462/1F | Original Q5

0 5 A student investigated the mass of copper oxide produced by heating copper carbonate.

This is the method used.

1. Weigh an empty test tube.
2. Weigh 2.00 g of copper carbonate into the test tube.
3. Heat the copper carbonate until there appears to be no further change.
4. Re-weigh the test tube and copper oxide produced.
5. Subtract the mass of the empty tube to find the mass of copper oxide.
6. Repeat steps 1–5 twice.
7. Repeat steps 1–6 with different masses of copper carbonate.

Table 4 shows the student's results.

Table 4

Mass of copper carbonate in g	Mass of copper oxide in g			
	Trial 1	Trial 2	Trial 3	Mean
2.00	1.29	1.27	1.31	1.29
4.00	2.89	2.57	2.59	2.58
6.00	3.85	3.90	3.87	3.87
8.00	5.12	5.15	5.09	**X**
10.00	6.42	6.45	6.45	6.44

The equation for the reaction is:

$$CuCO_3(s) \rightarrow CuO(s) + CO_2(g)$$

0 5 . 1 Complete the sentence.

[1 mark]

The state symbol shows carbon dioxide is a _____.

4.4.1.1 Metal oxides

Question 30 · continued

0 5 . 2 Why do the contents of the test tube lose mass in the investigation?

[1 mark]

0 5 . 3 Calculate the mean mass **X** in **Table 4**.

[1 mark]

X = _____ g

0 5 . 4 One of the results in **Table 4** is anomalous.

Which result is anomalous?

[1 mark]

Mass of copper carbonate _____ g Trial _____

0 5 . 5 Suggest how the investigation could be improved to make sure the reaction is complete.

[2 marks]

4.4.1.1 Metal oxides

Question 30 · continued

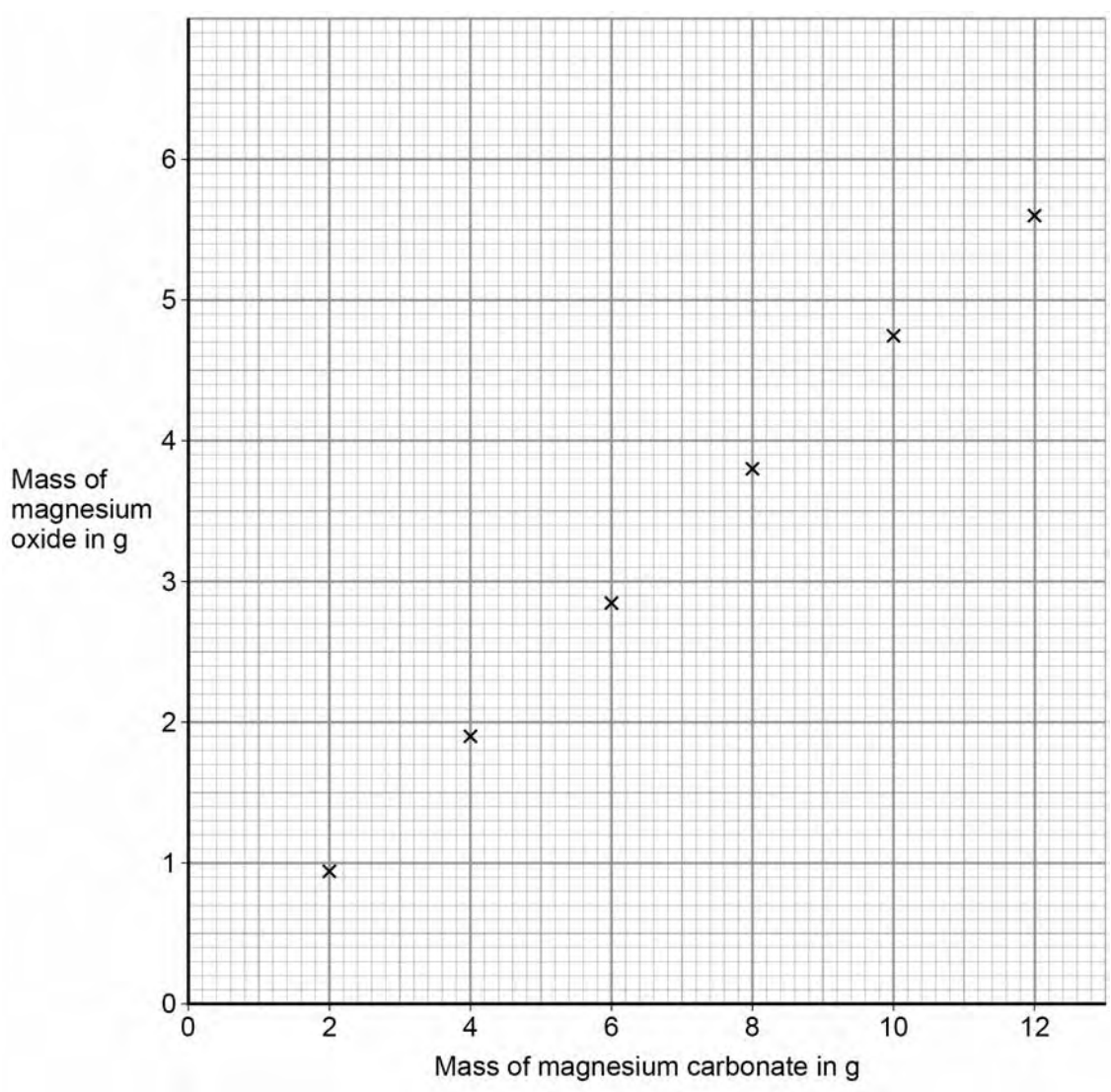
Another student repeated the investigation using magnesium carbonate instead of copper carbonate.

The word equation for the reaction is:

magnesium carbonate → magnesium oxide + carbon dioxide

Figure 8 shows the results of the investigation.

Figure 8



4.4.1.1 Metal oxides

Question 30 · continued

0 5 . 6 Draw a line of best fit on **Figure 8**.

[1 mark]

0 5 . 7 Determine the mass of magnesium oxide produced by 8.4 g of magnesium carbonate.

Use **Figure 8**.

[1 mark]

Mass = _____ g

0 5 . 8 Calculate the mass of magnesium oxide produced when 168 g of magnesium carbonate is heated.

Use your answer to Question **05.7**

[2 marks]

_____

_____

_____

_____

Mass of magnesium oxide produced = _____ g

4.4.1.1 Metal oxides

Question 31

June 2018 | 8462/1F | Original Q8

0 8 Soluble salts are formed by reacting metal oxides with acids.

0 8 . 1 Give **one** other type of substance that can react with an acid to form a soluble salt.

[1 mark]

0 8 . 2 Calcium nitrate contains the ions Ca^{2+} and NO_3^-

Give the formula of calcium nitrate.

[1 mark]

0 8 . 3 Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide and a dilute acid.

[6 marks]

4.4.1.1 Metal oxides

Question 32

June 2019 | 8462/1F | Original Q6

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 = _____ %

4.4.1.1 Metal oxides

Question 32 · 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

4.4.1.1 Metal oxides

Question 32 · 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

4.4.1.1 Metal oxides

Question 33

November 2020 | 8462/1F | Original Q5

0 5 This question is about aluminium.

0 5 . 1 Aluminium is a metal.

Draw **one** line from each property of aluminium to the correct reason for that property.

[2 marks]

Property	Reason
	Aluminium has delocalised electrons
Conducts electricity	Aluminium has layers of atoms which can slide
	Aluminium has strong metallic bonds
High melting point	Aluminium has weak intermolecular forces
	Aluminium has a random arrangement of atoms

0 5 . 2 Aluminium can be used to make alloys.

What is meant by an 'alloy'?

[1 mark]

4.4.1.1 Metal oxides

Question 33 · continued

Aluminium is extracted from bauxite.

Bauxite is a mixture which contains aluminium oxide.

0 5 . 3 Bauxite contains between 15% and 25% aluminium.

Aluminium oxide always contains 53% aluminium.

How does this show that bauxite is a mixture and **not** a compound?

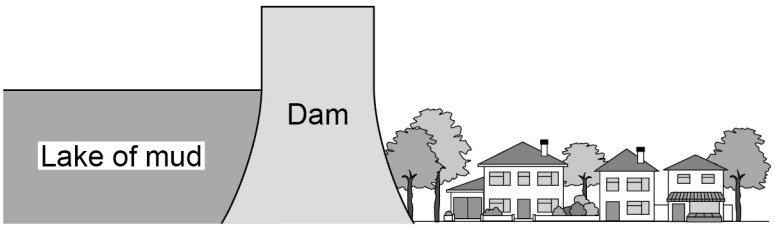
[1 mark]

0 5 . 4 The waste material from the bauxite is stored in lakes of mud.

The lakes of mud are held in place by dams.

Figure 6 shows one of these lakes.

Figure 6



Suggest **two** possible problems with storing the waste material in lakes of mud.

[2 marks]

1

2

4.4.1.1 Metal oxides

Question 33 · continued

Aluminium is extracted by electrolysis.

The aluminium oxide is mixed with cryolite and melted.

The mixture is then electrolysed.

0 5 . 5 The formula of cryolite is Na_3AlF_6

Give the total number of atoms in the formula.

[1 mark]

Number of atoms = _____

0 5 . 6 What is the reason for adding cryolite to the aluminium oxide?

[1 mark]

Tick (✓) **one** box.

To increase the amount of aluminium extracted ☐

To lower the melting point of the mixture ☐

To reduce the amount of aluminium oxide needed ☐

4.4.1.1 Metal oxides

Question 33 · continued

0 5 . 7 Complete the sentences.

Choose answers from the box.

[2 marks]

aluminium	**carbon**	**fluorine**
oxygen	**sodium**	

When the molten aluminium oxide and cryolite mixture is electrolysed the product at the positive electrode is _____.

This product reacts with the positive electrode because the positive electrode is made of _____.

0 5 . 8 A sample of bauxite contains 25% aluminium.

Calculate the maximum mass of aluminium that can be extracted from 300 000 kg of the sample of bauxite.

Give your answer in standard form.

[3 marks]

Maximum mass (in standard form) = _____ kg

13

4.4.1.1 Metal oxides

Question 34

November 2020 | 8462/1F | Original Q8

0 8 This question is about structure and bonding.

0 8 . 1 Which **two** substances have intermolecular forces between particles?

[2 marks]

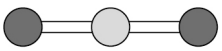
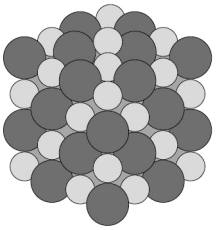
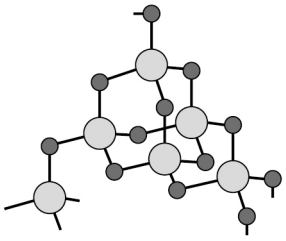
Tick (✓) **two** boxes.

- Diamond ☐
- Magnesium ☐
- Poly(ethene) ☐
- Sodium chloride ☐
- Water ☐

0 8 . 2 **Table 5** shows the structures of three compounds.

Table 5

Diagrams not to scale

Compound	Structure
Carbon dioxide	
Magnesium oxide	
Silicon dioxide	

4.4.1.1 Metal oxides

Question 34 · continued

Compare the structure and bonding of the three compounds:

- carbon dioxide
- magnesium oxide
- silicon dioxide.

[6 marks]

8

4.4.1.1 Metal oxides

Question 35

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** = _____

4.4.1.1 Metal oxides

Question 35 · 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

4.4.1.1 Metal oxides

Question 35 · 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

4.4.1.1 Metal oxides

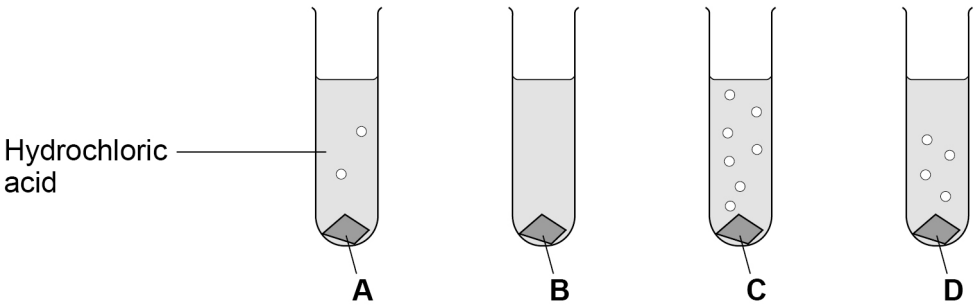
Question 36

0 3 This question is about acids.

A student added four metals, **A**, **B**, **C** and **D** to hydrochloric acid.

Figure 4 shows the rate of bubbling in each tube.

Figure 4



Use **Figure 4** to answer questions **03.1** and **03.2**.

0 3 . 1 Which metal is copper?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 3 . 2 Which metal is the most reactive?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 3 . 3 A metal oxide reacts with an acid to produce zinc sulfate and water.

Name the metal oxide and the acid used in this reaction.

[2 marks]

Name of metal oxide _____

Name of acid _____

4.4.1.1 Metal oxides

Question 36 · continued

0 3 . 4 Universal indicator is used to measure the pH of a solution.

Draw **one** line from each pH to the colour of universal indicator in a solution with that pH.

[2 marks]

pH	Colour of universal indicator
	Blue
1	Green
	Purple
7	Red
	Yellow

Question 3 continues on the next page

4.4.1.1 Metal oxides

Question 36 · continued

A student reacts an acid with an alkali in a titration.

0 3 . 5 What is the type of reaction when an acid reacts with an alkali?

[1 mark]

Tick (✓) **one** box.

- Combustion ☐
- Decomposition ☐
- Neutralisation ☐

0 3 . 6 **Figure 5** shows a piece of equipment used to measure the volume of the acid in the titration.

Figure 5



What is the name of this piece of equipment?

[1 mark]

Tick (✓) **one** box.

- Burette ☐
- Pipette ☐
- Syringe ☐
- Tube ☐

8

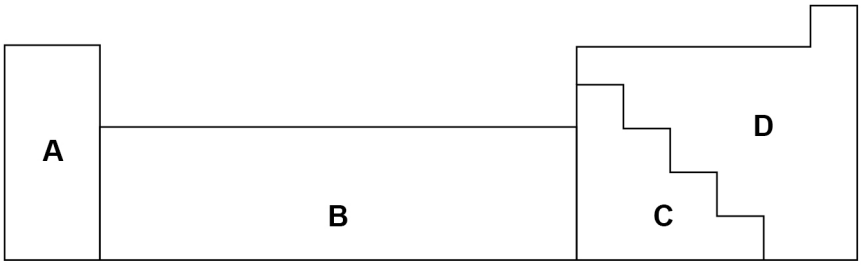
4.4.1.1 Metal oxides

Question 37

0 9 This question is about metals and non-metals.

Figure 15 shows an outline of part of the periodic table.

Figure 15



0 9 . 1 Element **Q** is a dull solid with a melting point of 44 °C.

Element **Q** does not conduct electricity.

Which section of the periodic table in **Figure 15** is most likely to contain element **Q**?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 9 . 2 Element **R** forms ions of formula R^{2+} and R^{3+}

Which section of the periodic table in **Figure 15** is most likely to contain element **R**?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 9 . 3 Give **two** differences between the physical properties of the elements in Group 1 and those of the transition elements.

[2 marks]

1 _____

_____

2 _____

_____

4.4.1.1 Metal oxides

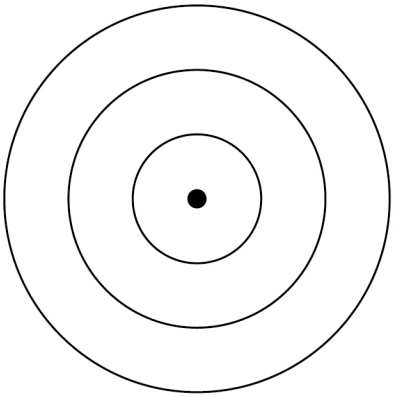
Question 37 · continued

0 9 . 4 Complete **Figure 16** to show the electronic structure of an aluminium atom.

Use the periodic table.

[1 mark]

Figure 16



0 9 . 5 Aluminium is a metal.

Describe how metals conduct electricity.

Answer in terms of electrons.

[3 marks]

0 9 . 6 Name the type of bonding in compounds formed between metals and non-metals.

[1 mark]

4.4.1.1 Metal oxides

Question 37 · continued

0 9 . 7 Magnesium oxide is a compound formed from the metal magnesium and the non-metal oxygen.

Describe what happens when a magnesium atom reacts with an oxygen atom.

You should refer to electrons in your answer.

[4 marks]

13

4.4.1.1 Metal oxides

Question 38

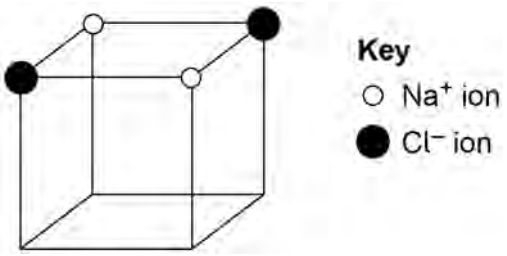
June 2023 | 8462/1F | Original Q7

0 7 This question is about ionic compounds and electrolysis.

Sodium chloride is an ionic compound.

0 7 . 1 **Figure 8** represents part of the structure of solid sodium chloride.

Figure 8



Complete **Figure 8**.

[2 marks]

0 7 . 2 Give **one** reason why molten sodium chloride conducts electricity.

Refer to ions in your answer.

[1 mark]

0 7 . 3 **Table 3** shows products of the electrolysis of two molten ionic compounds.

Complete **Table 3**.

[2 marks]

Table 3

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

4.4.1.1 Metal oxides

Question 38 · continued

0 7 . 4 Aluminium is extracted by electrolysis.

The electrolyte is a molten mixture of aluminium oxide and cryolite.

Why is a mixture used instead of pure aluminium oxide as the electrolyte?

[1 mark]

Tick (✓) **one** box.

- The mixture has a lower melting point than pure aluminium oxide. ☐
- The mixture has the same melting point as pure aluminium oxide. ☐
- The mixture has a higher melting point than pure aluminium oxide. ☐

0 7 . 5 Electrolysis of an aqueous solution of sodium sulfate produces hydrogen and oxygen.

What is the source of the hydrogen and the oxygen produced during the electrolysis of aqueous sodium sulfate solution?

[1 mark]

Tick (✓) **one** box.

- Air ☐
- Sulfate ions ☐
- Water ☐

Question 7 continues on the next page

Question 38 · continued

Electrolysis of an aqueous solution of sodium sulfate produces hydrogen and oxygen.

0 7 . 6 Why is hydrogen produced instead of sodium in the electrolysis of aqueous sodium sulfate solution?

[1 mark]

Tick (✓) **one** box.

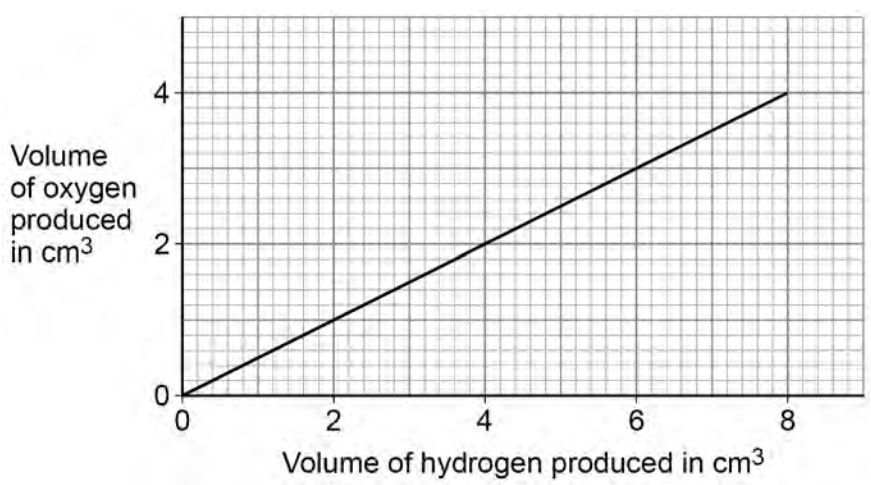
Hydrogen is less reactive than sodium. ☐

Hydrogen has the same reactivity as sodium. ☐

Hydrogen is more reactive than sodium. ☐

0 7 . 7 **Figure 9** shows the relationship between the volume of hydrogen and the volume of oxygen produced during the electrolysis.

Figure 9



Give **one** conclusion that can be made about the volume of hydrogen produced compared to the volume of oxygen produced.

[1 mark]

9

4.4.1.1 Metal oxides

Question 39

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 39 · 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]

4.4.1.1 Metal oxides

Question 39 · 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

4.4.1.1 Metal oxides

Question 40

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

4.4.1.1 Metal oxides

Question 40 · 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

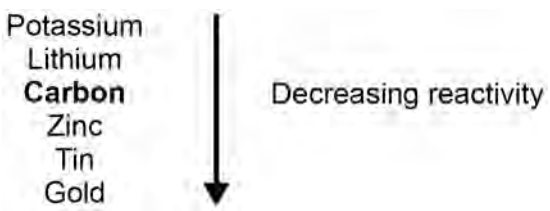
4.4.1.1 Metal oxides

Question 40 · 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

4.4.1.1 Metal oxides

Question 41

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

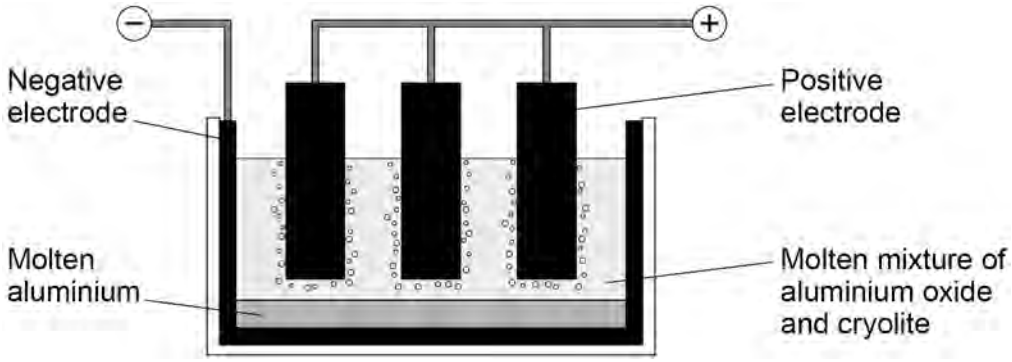
Molten compound	Product at the negative electrode	Product at the positive electrode
Copper chloride		Chlorine
Potassium bromide	Potassium	

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 ☐

4.4.1.1 Metal oxides

Question 41 · 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. ☐

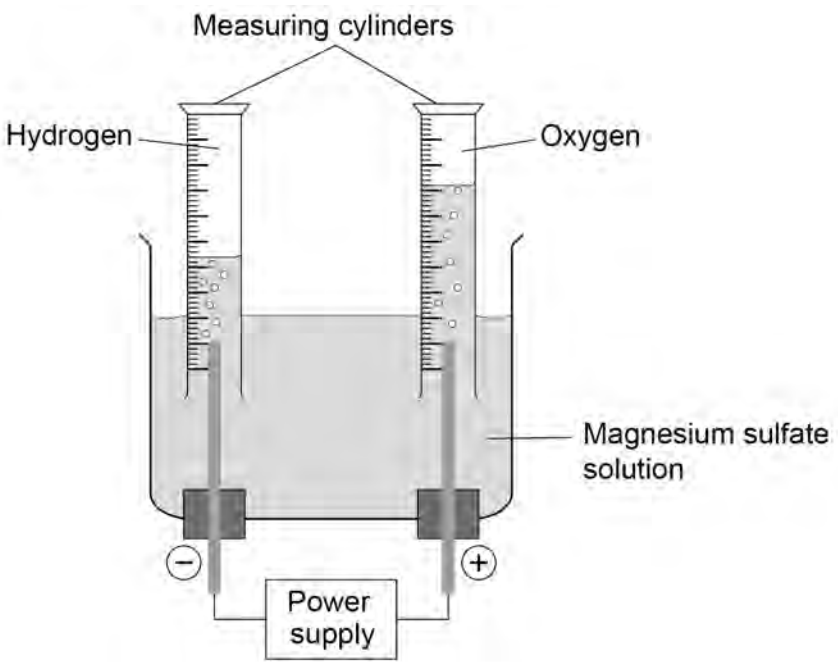
4.4.1.1 Metal oxides

Question 41 · 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.

4.4.1.1 Metal oxides

Question 41 · 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.

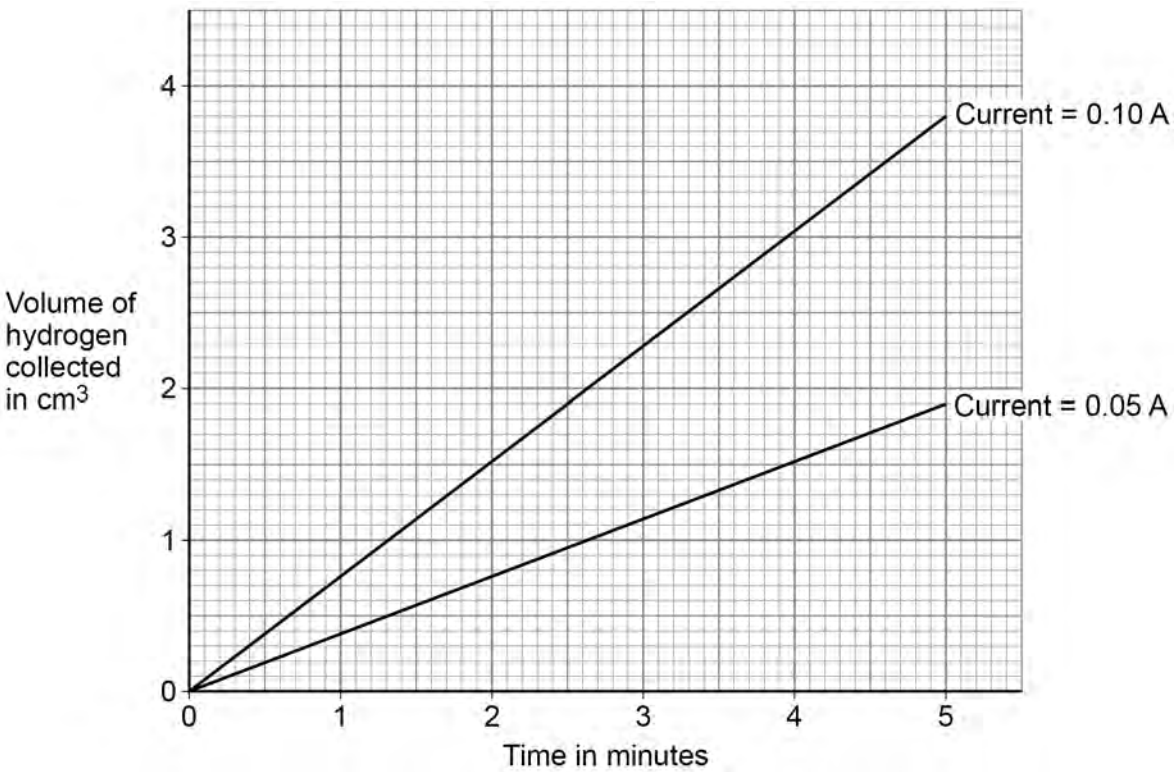
Hydrogen is less reactive than magnesium. ☐

Hydrogen has the same reactivity as magnesium. ☐

Hydrogen is more reactive than magnesium. ☐

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.

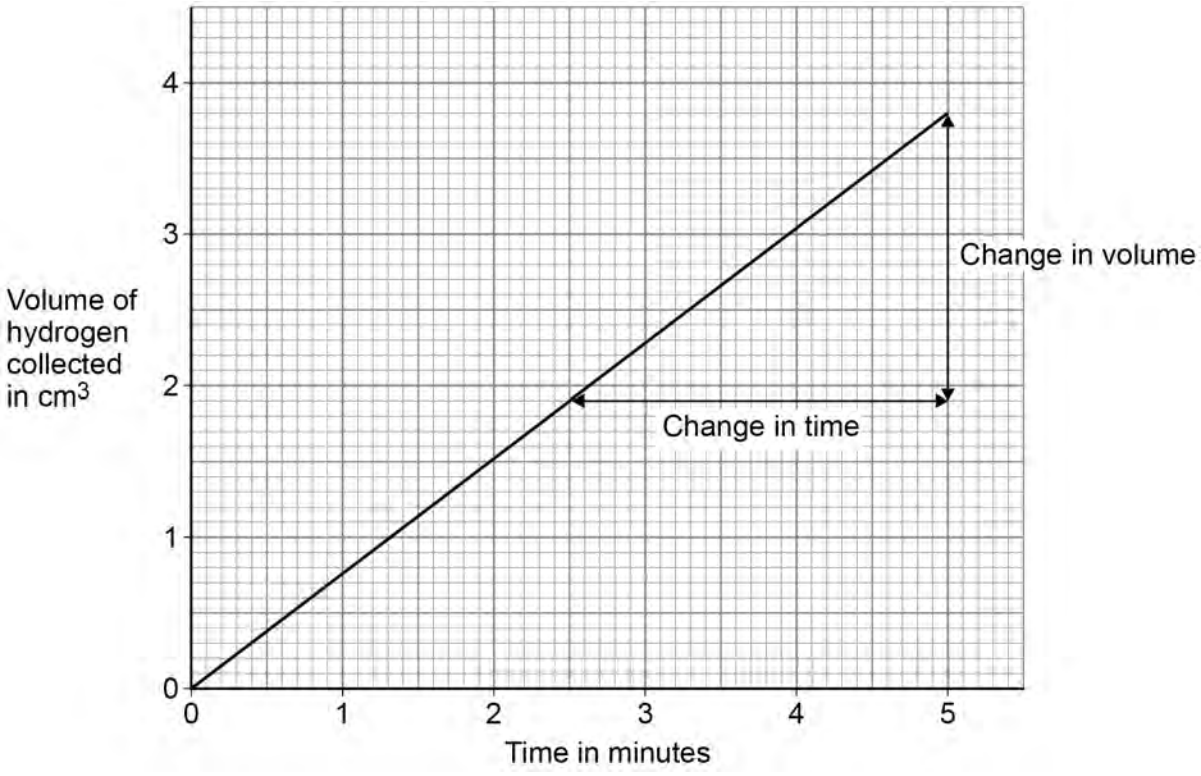
The volume of hydrogen collected depends on **both** the current and the time. ☐

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. ☐

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

4.4.1.1 Metal oxides

Question 42

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 42 · 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 _____

4.4.1.1 Metal oxides

Question 42 · continued June 2025 | 8462/1F | Original Q10

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