AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.1.1

Metal oxides

Past-paper questions

Tier	**Higher**
Question groups	**64**
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

January 2007 | CHY1H | Original Q3 | Legacy

3 Many everyday items are made from iron.

(a) Haematite is an *ore* of iron. Haematite contains iron oxide, Fe_2O_3.

(i) What is the meaning of the term *ore*?

.....

.....

(1 mark)

(ii) Iron can be produced by reacting iron oxide with carbon in a blast furnace.

What type of reaction produces the iron?

.....

.....

(1 mark)

(iii) The word equation for this reaction is:

iron oxide + carbon → iron + carbon dioxide

Complete and balance the symbol equation for this reaction.

.....Fe_2O_3 + ...C → ..... + ...

(2 marks)

Question 3 continues on the next page

4.4.1.1 Metal oxides

Question 01 · continued

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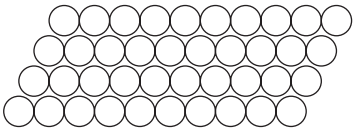
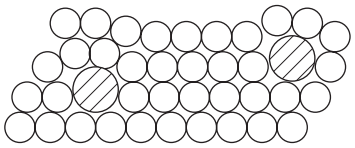
(b) Pure iron is relatively soft and not very strong.

The iron from the blast furnace is very hard and brittle. It contains about 4 % carbon and is used as cast iron.



Pure iron



Cast iron

Explain the differences in the properties of pure iron and cast iron by referring to the diagrams.

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(3 marks)

4.4.1.1 Metal oxides

Question 01 · continued

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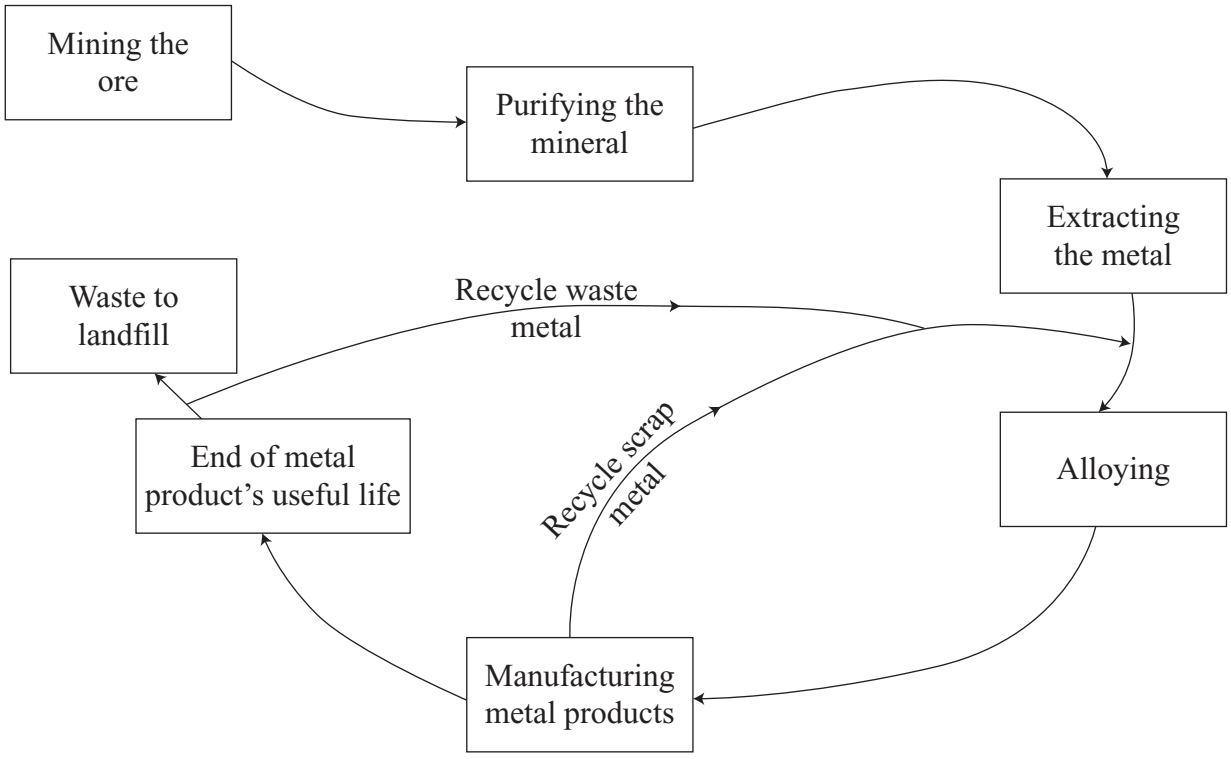
(c) The diagram shows the way in which iron is extracted, used and recycled.



Explain why the recycling of iron is necessary for sustainable development.

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(3 marks)

10

4.4.1.1 Metal oxides

Question 02

June 2007 | CHY1H | Original Q2 | Legacy

2 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.

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.....

.....

(2 marks)

4.4.1.1 Metal oxides

Question 02 · continued

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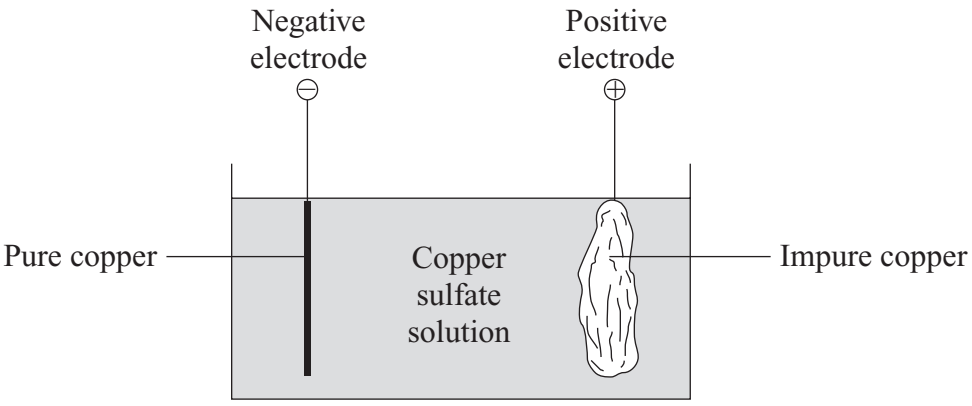
(c) During the third stage the copper can be purified as shown in the diagram.



(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 03

November 2007 | CHY1A | Original Q7 | Legacy

QUESTION SEVEN

Aluminium (7.85%) and iron (4.12%) are the two most abundant metals in the Earth's crust.

Iron is extracted from iron oxide in a blast furnace.

The equations show two reactions that occur in the furnace.

$$FeO + C \rightarrow Fe + CO$$

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

7A Which substances are reduced and which substances cause the reduction in these two reactions?

	Substances reduced	Substances causing the reduction
1	iron	carbon and carbon monoxide
2	iron oxides	carbon monoxide and carbon dioxide
3	carbon and carbon dioxide	iron oxides
4	iron oxides	carbon and carbon monoxide

7B Aluminium **cannot** be extracted from its ores in a blast furnace because . . .

1 it is more reactive than iron.

2 too many stages are needed in the process.

3 too much energy is required.

4 it is more reactive than carbon.

4.4.1.1 Metal oxides

Question 03 · continued

7C 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.

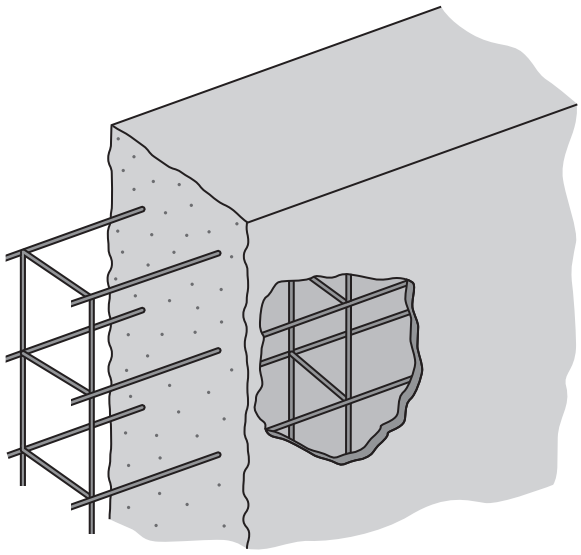
1 **W** and **X**

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

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

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

7D The diagram shows some reinforced concrete.



Which one of the following is the best material to use to reinforce concrete?

1 cast iron

2 low carbon steel

3 high carbon steel

4 stainless steel

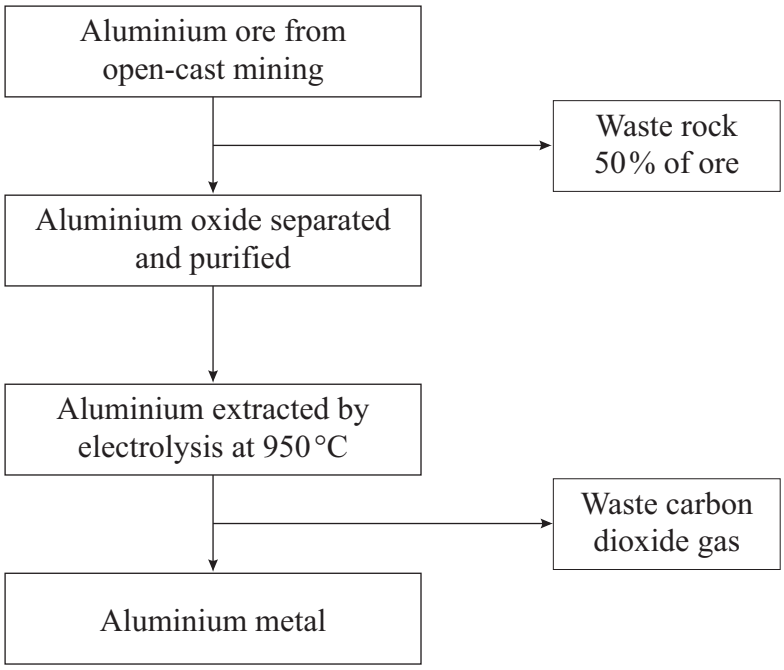
4.4.1.1 Metal oxides

Question 04

January 2008 | CHY1H | Original Q4 | Legacy

4 Aluminium has many uses because of its low density, good electrical conductivity, flexibility and resistance to corrosion.

The main steps in the extraction of aluminium are shown in the flow chart.



(a) Use the information in the flow chart to suggest the benefits of recycling aluminium.

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(3 marks)

4.4.1.1 Metal oxides

Question 04 · continued

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(b) Pure aluminium is rarely used for the construction of large objects. Small amounts of other metals are usually mixed with aluminium.

Explain why.

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.....

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(2 marks)

5

Turn over for the next question

4.4.1.1 Metal oxides

Question 05

January 2008 | CHY2H | Original Q5 | Legacy

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



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

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

State the meaning of *exothermic*.

.....

.....

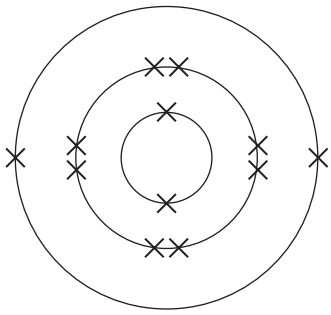
(1 mark)

(b) Write a balanced symbol equation for the reaction between magnesium (Mg) and oxygen (O_2) to form magnesium oxide (MgO).

.....

(1 mark)

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



Magnesium atom

Draw a similar diagram to show the electronic structure of an oxygen atom.
The atomic (proton) number of oxygen is 8.

(1 mark)

4.4.1.1 Metal oxides

Question 05 · continued

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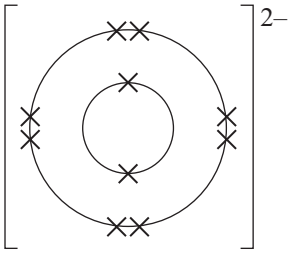
(d) Magnesium ions and oxide ions are formed when magnesium reacts with oxygen.

The diagram shows the electronic structure of an oxide ion.



Oxide ion

Draw a similar diagram to show the electronic structure of a magnesium ion.

(1 mark)

(e) Magnesium oxide is a white solid with a high melting point.

Explain how the ions are held together in solid magnesium oxide.

.....

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.....

.....

(2 marks)

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

Complete the word equation for the reaction between magnesium oxide and hydrochloric acid.

hydrochloric acid + magnesium oxide → ..... + water.

(1 mark)

7

4.4.1.1 Metal oxides

Question 06

June 2008 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

- 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.

3A 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

3B 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.

4.4.1.1 Metal oxides

Question 06 · continued June 2008 | CHY1AP | Original Q3 | Legacy

- 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.

3C 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

3D 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.

4.4.1.1 Metal oxides

Question 07

June 2008 | CHY2H | Original Q3 | Legacy

3 Copper sulfate ($CuSO_4$) is a salt that has many uses.

An aqueous solution of copper sulfate can be made by reacting copper oxide (CuO) with an acid.

3 (a) (i) Name this acid. .....

(1 mark)

3 (a) (ii) Write a balanced symbol equation, including state symbols, for this reaction.

.....

(2 marks)

3 (b) Copper oxide reacts much faster with acid at 40 °C than at 20 °C.

Explain why in terms of particles.

.....

.....

.....

.....

(2 marks)

5

4.4.1.1 Metal oxides

Question 08

March 2009 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about the production of metals.

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

A decomposed

B acidified

C reduced

D extracted

Some metals are produced from their carbonate ores.

The ores are first . . . **1** . . . from the ground.

They are then heated until the metal carbonate is . . . **2** . . . .

When the ore is heated, sulfur impurities may react with air and eventually cause rainwater to be . . . **3** . . . .

Finally, the metal oxide can be reacted with carbon and so be . . . **4** . . . to the metal.

4.4.1.1 Metal oxides

Question 09

March 2009 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

A scientist investigated the chemistry of four metals, **W**, **X**, **Y** and **Z**.

These are the results.

- The oxides of **W** and **Y** were reduced to the metal when mixed with carbon and heated.
- The oxide of **Z** could not be reduced by heating with carbon.
- The oxide of **X** decomposed to the metal on heating alone.
- **Y** gave off hydrogen gas with dilute acid but **W** and **X** did not.

9A Starting with the most reactive, what is the order of reactivity for the four metals?

1 **X**, **W**, **Y**, **Z**

2 **Z**, **Y**, **W**, **X**

3 **X**, **W**, **Z**, **Y**

4 **Z**, **W**, **Y**, **X**

9B Which metal is most likely to be found in the ground as the pure metal?

1 **W**

2 **X**

3 **Y**

4 **Z**

9C How would metal **Z** be produced?

1 by mixing the oxide of **Z** with carbon and heating

2 by mixing an oxide of **Z** with the metal **W** and heating

3 by electrolysis of a molten oxide of **Z**

4 by heating the oxide of **Z** in a stream of hydrogen gas

4.4.1.1 Metal oxides

Question 09 · continued March 2009 | CHY1AP | Original Q9 | Legacy

9D The equation for the reduction of the oxide of **W** to the metal **W** can be represented by the following equation:

$$2\mathbf{W}_2O_3 + \boldsymbol{q}C = 3CO_2 + \boldsymbol{r}\mathbf{W}$$

What values of ***q*** and ***r*** are needed to balance the equation?

1 ***q*** = 3 and ***r*** = 4

2 ***q*** = 2 and ***r*** = 2

3 ***q*** = 4 and ***r*** = 2

4 ***q*** = 3 and ***r*** = 2

END OF TEST

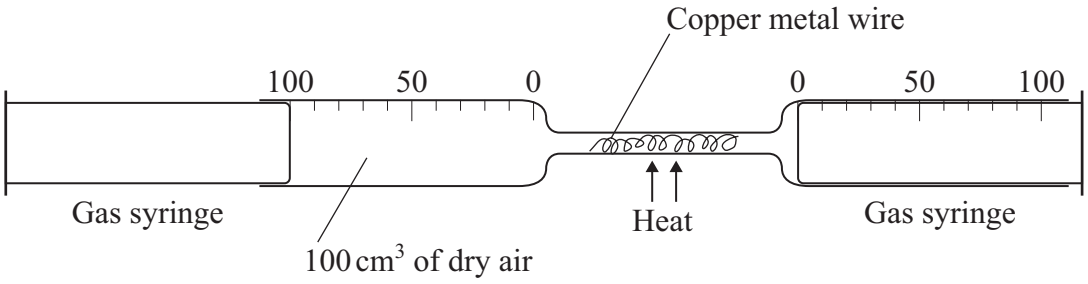
4.4.1.1 Metal oxides

Question 10

March 2009 | CHY1BP | Original Q5 | Legacy

QUESTION FIVE

The diagram shows some apparatus that is used to investigate the composition of air.



100 cm^3 of dry air was passed backwards and forwards over heated copper metal wire, using the gas syringes.
The copper reacts with oxygen in the dry air to produce copper oxide.
The process was continued until there was no further reduction in the volume of the gases in the syringes. The apparatus was then allowed to cool.

5A Why is it important to continue heating to a constant volume?

1 The volume of air is greater at higher temperatures.

2 Copper oxide will decompose as the apparatus cools.

3 To be sure that all the oxygen in the air has reacted.

4 So that all of the copper has been converted to copper oxide.

5B What was the final volume of gas left in the syringes at the end of the experiment?

1 40 cm^3

2 60 cm^3

3 80 cm^3

4 100 cm^3

4.4.1.1 Metal oxides

Question 10 · continued

5C Which substance will be the main gas left in the syringes at the end of the experiment?

1 nitrogen

2 oxygen

3 carbon dioxide

4 a noble gas

5D Which of the following is the balanced symbol equation for the reaction between copper and oxygen?

1 $Cu + O_2 \rightarrow CuO$

2 $Cu + 2O_2 \rightarrow CuO$

3 $2Cu + O_2 \rightarrow 2CuO$

4 $2Cu + 2O_2 \rightarrow 2CuO$

4.4.1.1 Metal oxides

Question 11

June 2009 | CHY1AP | Original Q7 | Legacy

QUESTION SEVEN

This question is about three metals, copper, lead and zinc.

7A Copper is found in the Earth's crust as the metal itself.

Lead and zinc are also found in the Earth's crust, but only as compounds such as oxides and sulfides.

These facts suggest that . . .

1 copper is a very reactive metal.

2 lead and zinc are transition metals, but copper is not.

3 lead and zinc react rapidly with oxygen and sulfur, but copper does not.

4 lead and zinc are more reactive than copper.

7B A naturally occurring compound of zinc is hydrozincite, $2ZnCO_3.3Zn(OH)_2$

Which row in the table correctly shows the number of elements, and the number of atoms of oxygen in the formula for hydrozincite?

	Number of elements	Number of atoms of oxygen
1	4	12
2	4	8
3	5	5
4	6	4

Question 11 · continued

7C Zinc is also found as zincite, ZnO.

The metal can be extracted from zincite by mixing it with carbon and heating strongly.

Which row in the table correctly shows the name for this process and the products?

	Name of process	Products
1	electrolysis	zinc and carbon dioxide
2	leaching	zinc and oxygen
3	reduction	zinc and oxygen
4	reduction	zinc and carbon dioxide

Lead and zinc compounds are often found together in the same ore.

The metals can be extracted by mixing the ore with carbon and heating strongly in a furnace. They can then be separated.

The table shows the melting points and boiling points of lead and zinc.

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

The furnace operates at a temperature of 1200 °C.

7D How will the lead and zinc be separated?

1 Molten lead remains in the furnace and the zinc evaporates.

2 Molten lead and molten zinc form two separate layers in the furnace.

3 Molten zinc remains in the furnace and the lead evaporates.

4 Zinc and lead vapours leave the furnace and are separated in a condenser.

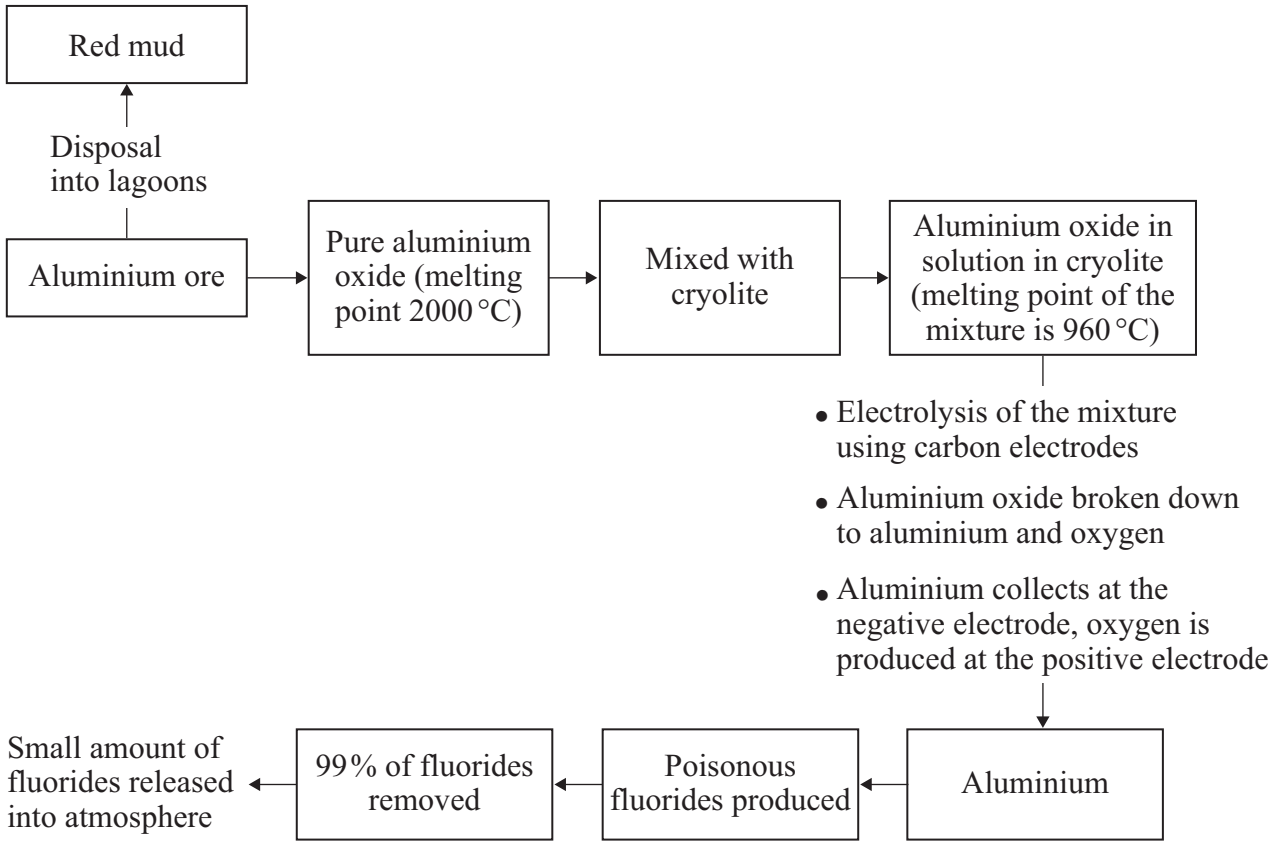
4.4.1.1 Metal oxides

Question 12

June 2009 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

The flow chart shows the stages in the extraction of aluminium.



9A The red mud from the aluminium ore is disposed of by dumping in lagoons. The red mud contains iron oxide.

The most likely reason why iron is **not** extracted from the red mud is that . . .

1 the iron oxide evaporates too quickly.

2 there is no transportation system nearby.

3 it is **not** economic compared to other sources of iron.

4 iron oxide from the lagoons cannot be reduced by carbon.

4.4.1.1 Metal oxides

Question 12 · continued June 2009 | CHY1AP | Original Q9 | Legacy

9B Why is pure aluminium oxide mixed with cryolite before electrolysis?

1 to produce an aluminium alloy

2 to reduce the breakdown of aluminium oxide

3 to lower the melting point so less energy is used during electrolysis

4 to react with impurities in the aluminium oxide

9C During electrolysis, the positive carbon electrode is rapidly used up causing emissions.

The main component of these emissions contributes to . . .

1 global dimming.

2 global warming.

3 acid rain.

4 red mud lagoons.

9D It is important to monitor the amount of poisonous fluorides released into the atmosphere.

Plants absorb these fluorides. The amounts of fluorides in plants can be found by chemical analysis.

The best information would be found by chemical analysis of plants that are growing . . .

1 in all the workers' homes.

2 at exactly one kilometre in all directions from the factory.

3 at various distances in all directions from the factory.

4 at various distances in an easterly direction from the factory.

END OF TEST

4.4.1.1 Metal oxides

Question 13

November 2009 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about four chemical substances involved in the two chemical reactions below.

$$ZnCO_3 \rightarrow ZnO + \text{Substance } \mathbf{X}$$

$$2ZnO + C \rightarrow 2Zn + \text{Substance } \mathbf{X}$$

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

A $ZnCO_3$

B C

C CO_2

D ZnO

1	It is the metal oxide produced by thermal decomposition.
2	It has a formula made up of five atoms of three different elements.
3	It is the compound produced in both reactions.
4	It will burn in a limited supply of air to produce carbon monoxide and carbon dioxide.

4.4.1.1 Metal oxides

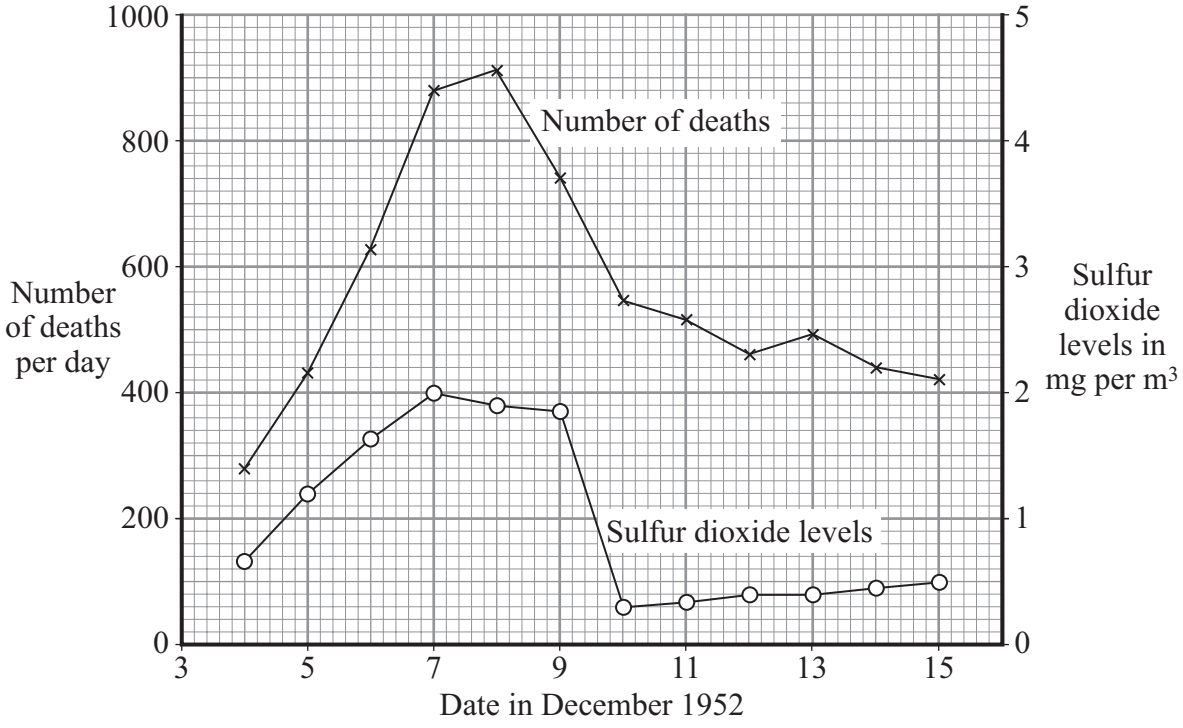
Question 14

November 2009 | CHY1AP | Original Q7 | Legacy

QUESTION SEVEN

Smog is a mixture containing sulfur dioxide and smoke particles.

The graph below shows how the number of deaths due to sulfur dioxide varied during the Great Smog in London during December 1952.



7A It is generally agreed that sulfur dioxide caused the increase in the number of deaths in London in December 1952.

Which of the following would be the best argument **against** this conclusion?

1 The level of sulfur dioxide does **not** go as high as the number of deaths.

2 After a period of time, the sulfur dioxide levels increase but the number of deaths decreases.

3 The graphs show a similar pattern of increase and decrease.

4 The number of deaths increases faster than the sulfur dioxide levels increase.

Question 14 · continued November 2009 | CHY1AP | Original Q7 | Legacy

7B A group of students studying the Great Smog of London in 1952 wrote four statements after looking at the data.

Which one of their statements is correct?

1 The number of deaths peaks on the same day as sulfur dioxide levels peak.

2 The number of deaths always increases when sulfur dioxide levels increase.

3 On the day that sulfur dioxide levels reached 2 mg per m^3, there were 880 deaths.

4 If sulfur dioxide levels double, the number of deaths doubles.

7C Many cars now use low-sulfur fuels that were introduced in 2000. However, the amount of sulfur dioxide emissions from vehicles in the UK has increased since 2000.

This increase is because . . .

1 early versions of low-sulfur fuels did not burn correctly.

2 there is an increasing number of vehicles on UK roads.

3 there is now 5 % ethanol (C_2H_5OH) in petrol.

4 sulfur dioxide is producing acid rain.

7D Sulfur dioxide can be removed from the waste gases from power stations using a process called flue gas desulfurisation. This is done by reacting the sulfur dioxide [SO_2] with calcium carbonate [$CaCO_3$], calcium oxide [CaO], calcium hydroxide [$Ca(OH)_2$] or magnesium oxide [MgO].

Which one of the following is **not** a correctly balanced equation for a reaction taking place during *flue gas desulfurisation*?

1 $SO_2 + MgO \rightarrow MgSO_3$

2 $SO_2 + CaO \rightarrow CaSO_3$

3 $SO_2 + CaCO_3 \rightarrow CaSO_3 + CO_2$

4 $SO_2 + Ca(OH)_2 \rightarrow CaSO_3 + 2H_2O$

4.4.1.1 Metal oxides

Question 15

November 2009 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

The equations show three reactions of the metal magnesium.

$$3Mg + Fe_2O_3 \rightarrow 3MgO + 2Fe$$

$$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$$

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

8A Magnesium **cannot** be produced by heating magnesium oxide with carbon.

Which row in the table correctly shows the order of reactivity for iron, magnesium and carbon?

	Most reactive ⟶		Least reactive
1	magnesium	carbon	iron
2	magnesium	iron	carbon
3	iron	carbon	magnesium
4	carbon	iron	magnesium

8B When magnesium reacts with hydrochloric acid, hydrogen is given off.
When excess magnesium is used and all the acid has reacted, hydrogen continues to be given off from the remaining magnesium.

The probable reason is that . . .

1 magnesium reacts with water to form hydrogen and magnesium hydroxide.

2 magnesium reacts with water to form hydrogen and oxygen.

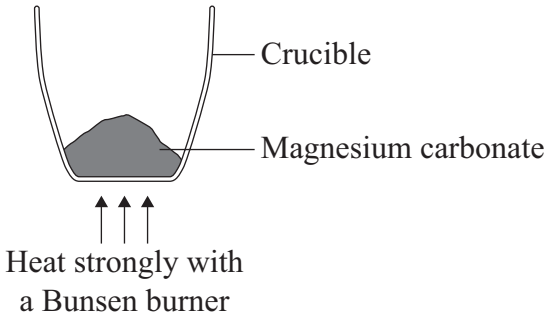
3 magnesium reacts with oxygen from the air to form hydrogen and magnesium oxide.

4 magnesium oxide decomposes to form magnesium, oxygen and hydrogen.

4.4.1.1 Metal oxides

Question 15 · continued

A student heated some magnesium carbonate in an open crucible.



The table shows the mass of the crucible and its contents at two-minute intervals.

Time in minutes	0	2	4	6	8
Mass of crucible and contents in grams	20.80	20.55	20.25	19.85	19.85

8C Which solid substances will the crucible contain after heating for two minutes?

1 magnesium carbonate only

2 magnesium oxide only

3 magnesium carbonate and magnesium oxide

4 magnesium and magnesium oxide

8D The student found that when the experiment was repeated using sodium carbonate instead of magnesium carbonate, there was no loss in mass.

The best conclusion that the student could make is that sodium carbonate . . .

1 does **not** decompose when heated.

2 only decomposes when heated gently.

3 only decomposes when heated to a very high temperature.

4 does **not** decompose at Bunsen burner temperatures.

4.4.1.1 Metal oxides

Question 16

March 2010 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about types of reactions.

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

A reduction

B combustion

C thermal decomposition

D corrosion

	Example of the type of reaction
1	Copper carbonate forms copper oxide and carbon dioxide when heated.
2	Hydrogen reacts with oxygen to produce water.
3	Carbon steels react when exposed to air and water.
4	Zinc is obtained from zinc oxide by removal of the oxygen.

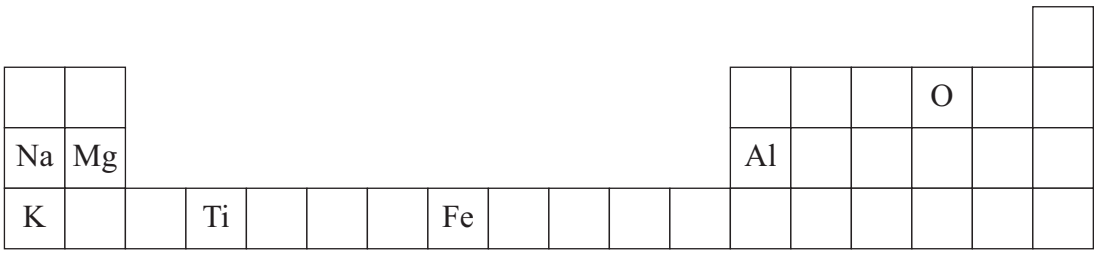
4.4.1.1 Metal oxides

Question 17

March 2010 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

This is part of the periodic table.



3A 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.

3B 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.

4.4.1.1 Metal oxides

Question 17 · continued

3C Fe (iron) and O (oxygen) are in the periodic table but Fe_2O_3 (iron oxide) is not.

This is because iron oxide is . . .

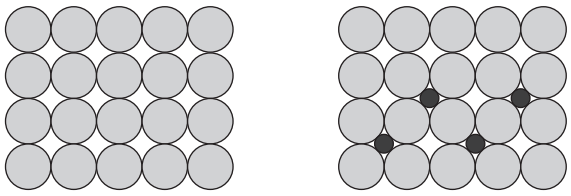
1 an alloy.

2 a compound.

3 an ore.

4 a gas.

3D 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 18

June 2010 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about the substances in this reaction:

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

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

A C

B Fe

C CO

D Fe_2O_3

1	In the reaction, it is reduced.
2	It is a transition element.
3	In the reaction, it is oxidised.
4	It is formed by oxidation of a non-metal element.

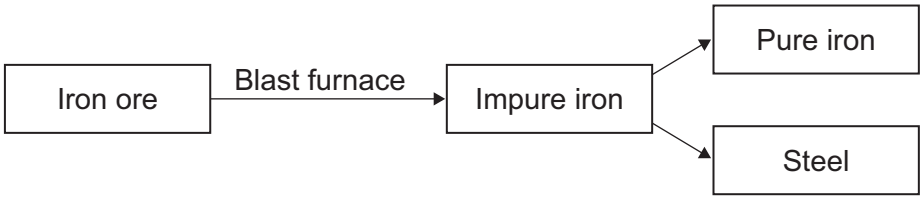
4.4.1.1 Metal oxides

Question 19

June 2010 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

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



3A 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.

3B 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.

4.4.1.1 Metal oxides

3C 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.

3D 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.

Turn over for the next question

4.4.1.1 Metal oxides

Question 20

June 2010 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

This question is about metals.

9A A scientist investigated some reactions of three metals, **K**, **L** and **M**.

- Metal **L** can be extracted by mixing its oxide with carbon and heating.
- Metal **M** cannot be extracted by mixing its oxide with carbon and heating.
- Hydrogen will displace metal **K** from its oxide but will not displace metal **L** from its oxide.
- The oxide of metal **K** is decomposed to the metal on heating alone.

The order of reactivity for the three metals, with the most reactive first, is . . .

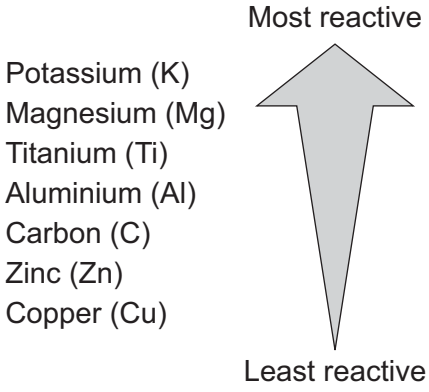
1 **K, L, M.**

2 **M, L, K.**

3 **L, K, M.**

4 **K, M, L.**

9B The order of reactivity for several metals and carbon is shown below.



Which of the following shows a correctly balanced equation for a possible reaction?

1 $ZnO + C \rightarrow Zn + CO_2$

2 $Cu + MgO \rightarrow CuO + Mg$

3 $2Mg + K_2O \rightarrow 2MgO + 2K$

4 $2Al + 3ZnO \rightarrow 3Zn + Al_2O_3$

4.4.1.1 Metal oxides

Titanium is extracted from titanium chloride by mixing the titanium chloride with sodium and heating the mixture. The reaction is carried out in a furnace above 500 °C.

It is a batch process; this means that the furnace does not operate continuously but is cooled after each operation so that the titanium can be removed.

9C Which row in the table correctly describes the reaction for the extraction of titanium?

	Why the reaction occurs	Products of the reaction
1	Sodium is more reactive than titanium	Titanium, sodium and chlorine
2	Titanium is more reactive than sodium	Titanium and chlorine
3	Titanium is more reactive than sodium	Titanium and sodium chloride
4	Sodium is more reactive than titanium	Titanium and sodium chloride

9D The extraction of iron in a blast furnace is a continuous process.

Over a period of 12 months, the batch method for extraction of titanium requires much more energy per tonne of metal than the continuous method for the extraction of iron.

This is because . . .

1 the batch process is completed more quickly.

2 iron is less reactive than titanium.

3 the furnace is not maintained at a high temperature.

4 titanium chloride is not as pure as iron oxide.

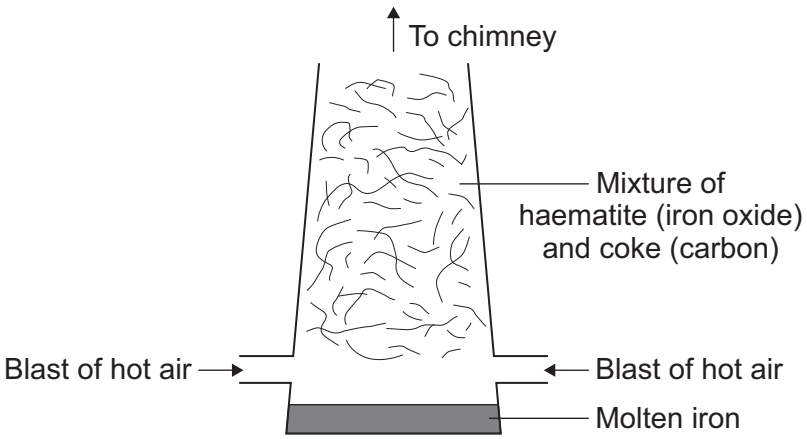
END OF TEST

4.4.1.1 Metal oxides

Question 21

June 2010 | CHY1H | Original Q3 | Legacy

3 Iron is produced by reacting a mixture of haematite and coke in a blast furnace.
Haematite is an ore of iron containing iron oxide (Fe_2O_3).
Coke is made from coal and is almost pure carbon.



3 (a) (i) The coke burns in air. This reaction heats the furnace to above 1300 °C.

Complete the chemical equation for carbon reacting with oxygen to form carbon dioxide.

..... + O_2 → CO_2

(1 mark)

3 (a) (ii) Carbon monoxide is also formed in the furnace. Carbon monoxide reacts with iron oxide to produce iron and carbon dioxide.

iron oxide + carbon monoxide → iron + carbon dioxide

Complete and balance the chemical equation for the production of iron.

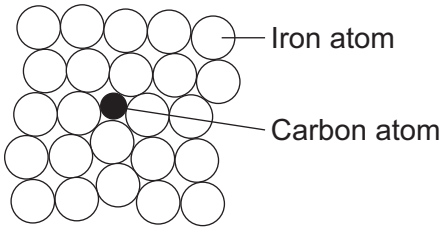
Fe_2O_3 + 3CO → ..... + ...

(2 marks)

4.4.1.1 Metal oxides

Question 21 · continued

3 (a) (iii) Iron from a blast furnace is called cast iron and contains about 4% carbon.



Why is pure iron softer than cast iron?

.....

.....

.....

(1 mark)

3 (b) Steel is made by reducing the percentage of carbon in cast iron and then adding different metals to form the type of steel required.

In the UK we use about 1.8 billion steel cans every year but only 30% of these are recycled. Recycling reduces waste. Producing steel from recycled cans requires only 25% of the energy needed to make steel from iron ore.

Give **three** environmental benefits of recycling a higher percentage of used steel cans.

1 .....

.....

2 .....

.....

3 .....

.....

(3 marks)

7

4.4.1.1 Metal oxides

Question 22

November 2010 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

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 23

November 2010 | CHY1AP | Original Q4 | Legacy

QUESTION FOUR

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.

4A Bauxite is an example of . . .

1 an element.

2 a compound.

3 an ore.

4 a solution.

4B The process used to extract aluminium is . . .

1 thermal decomposition.

2 reduction.

3 corrosion.

4 distillation.

4C 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.

4D 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.

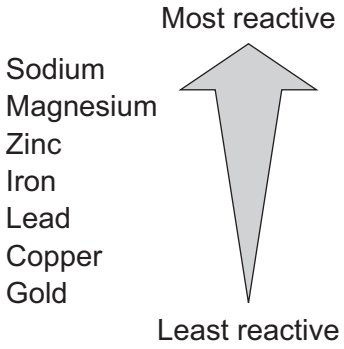
4.4.1.1 Metal oxides

Question 24

November 2010 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

A metal will displace a less reactive metal from its compounds.



If a reaction occurs, it releases heat. The reactivity of metals can be investigated by measuring the temperature rise if a fair test is carried out between metals and metal compounds.

Metal	Metal compound	Temperature rise in °C
Zinc	Lead nitrate	10
Iron	Lead nitrate	6
Zinc	Copper sulfate	19
Magnesium	Copper sulfate	48
Copper	Zinc sulfate	0

8A The results in the table suggest that the largest rise in temperature occurs when . . .

1 a metal reacts with a metal compound that is a sulfate.

2 a transition metal is used with a metal compound.

3 there is a large difference in reactivity between the metal used and the metal in the metal compound.

4 a Group 1 metal reacts with a transition metal compound.

4.4.1.1 Metal oxides

8B Using copper and zinc sulfate does **not** cause a temperature rise.

This is because . . .

1 not enough copper is used.

2 zinc is more reactive than copper.

3 copper corrodes easily.

4 too much zinc sulfate is added.

8C Which of the following metals will cause the largest temperature rise when added to iron nitrate solution?

1 gold

2 sodium

3 lead

4 zinc

8D
- Carbon can reduce zinc oxide.
- Magnesium can react with carbon dioxide.
- Carbon can produce iron from iron oxide.

Where should carbon be placed in the reactivity series?

1 above magnesium but below sodium

2 above zinc but below magnesium

3 below iron but above lead

4 below lead but above copper

4.4.1.1 Metal oxides

Question 25

January 2011 | CHY1H | Original Q1 | Legacy

1 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

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

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

.....

.....

.....

(1 mark)

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

.....

.....

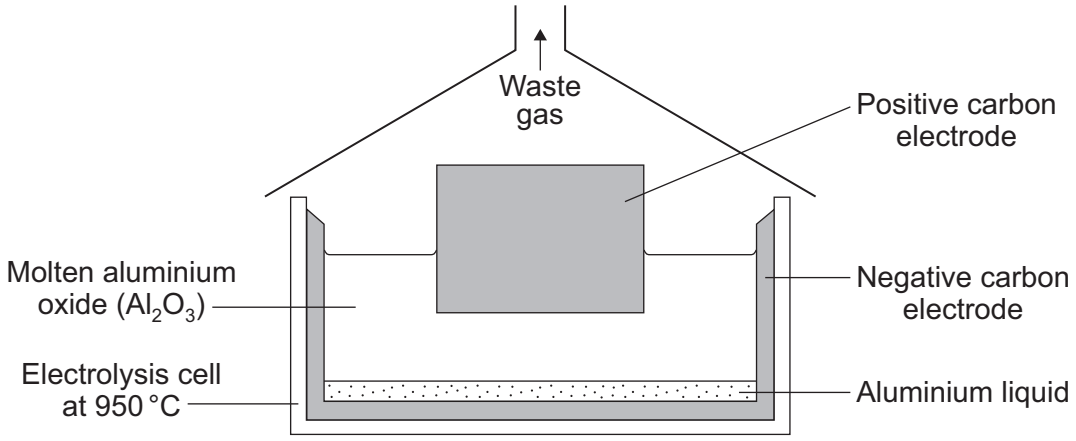
.....

(1 mark)

4.4.1.1 Metal oxides

Question 25 · continued

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



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

.....

.....

(1 mark)

1 (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)

1 (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 26

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



2 (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.

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

.....

.....

.....

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

2 (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 26 · continued

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

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

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

.....

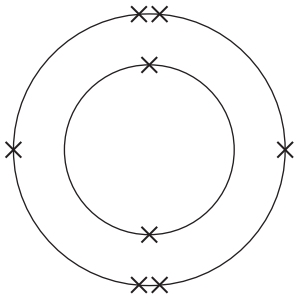
.....

.....

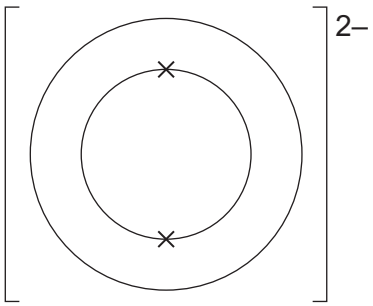
.....

(2 marks)

2 (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 27

March 2011 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about the positions of four metals in the reactivity series.

- Only metal **C** can be extracted by heating the metal oxide in hydrogen.
- Only metals **B** and **C** can be extracted by mixing their oxides with carbon and heating strongly.
- When the oxide of metal **A** is mixed with metal **D** and heated, metal **A** is produced.

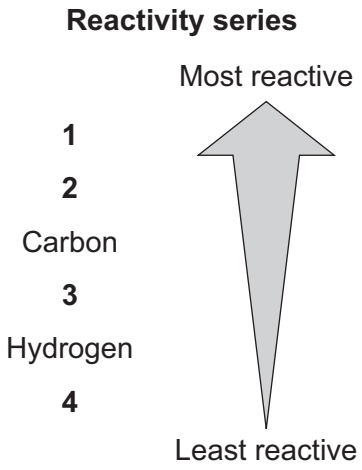
Match metals, **A**, **B**, **C** and **D**, with the numbers **1–4** in the reactivity series.

A Metal **A**

B Metal **B**

C Metal **C**

D Metal **D**



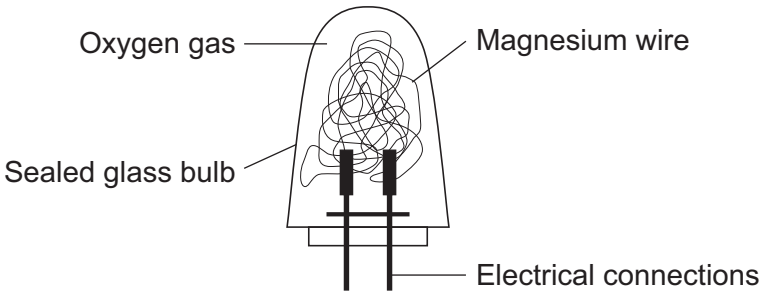
4.4.1.1 Metal oxides

Question 28

March 2011 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

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.

3A 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.

Question 28 · continued

3B 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.

3C 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

3D 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 29

March 2011 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

Zinc is a reactive metal that will react with oxygen at high temperatures. Its two main ores are zinc sulfide (ZnS) and zinc carbonate ($ZnCO_3$). The relative abundance of each ore is about the same throughout the world.

To extract zinc, the ores are first heated to produce zinc oxide:

$$2ZnS + 3O_2 \xrightarrow{\text{heat}} 2ZnO + 2SO_2$$

$$ZnCO_3 \xrightarrow{\text{heat}} ZnO + CO_2$$

The zinc oxide is mixed with carbon (C) and heated in a furnace.

In the furnace, these reactions occur:

$$C + O_2(air) \xrightarrow{\text{heat}} CO_2$$

$$CO_2 + C \longrightarrow 2CO$$

Zinc is extracted by the following reaction:

$$ZnO + CO \longrightarrow Zn + CO_2$$

8A An advantage of using zinc carbonate instead of zinc sulfide is that. . .

1 zinc carbonate is more common and therefore cheaper.

2 only one waste product is formed.

3 less zinc is lost during the reaction.

4 zinc is formed directly without another chemical being used.

8B The atmosphere inside the furnace is kept rich in carbon monoxide (CO).

This is to . . .

1 prevent zinc oxide from reacting with carbon (C).

2 stop the zinc from re-forming zinc oxide.

3 remove carbon (C) from the furnace.

4 make carbon dioxide (CO_2).

4.4.1.1 Metal oxides

Question 29 · continued

8C Zinc ores also contain lead compounds. Lead is produced with the zinc in the furnace. The temperature inside the furnace is about 1500 °C.

	Boiling point in °C	Density in g per cm^3	Reactivity
Lead	1749	11.3	Low
Zinc	907	7.1	High

Pure zinc is obtained from the furnace because . . .

1 zinc leaves the furnace as vapour, and liquid lead remains in the furnace.

2 liquid zinc floats on liquid lead in the furnace.

3 lead leaves the furnace as vapour, and liquid zinc remains in the furnace.

4 lead is more reactive than zinc and reacts with oxygen to form lead oxide.

8D Limestone is added to the furnace because . . .

1 it provides energy for the reaction.

2 it removes any acidic impurities.

3 it is the only source of the carbon dioxide in the furnace.

4 it is thermally stable.

4.4.1.1 Metal oxides

Question 30

June 2011 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

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 31

June 2011 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

Iron and copper can be extracted from their oxides by reduction with carbon.
Aluminium cannot be extracted from its oxide in this way.

Copper can be found in the Earth's crust as the metal itself.
Iron and aluminium are found only as compounds in the Earth's crust.

5A Which row in the table shows the order of reactivity of the four elements in the passage above?

	Most reactive → Least reactive			
1	copper	iron	aluminium	carbon
2	aluminium	carbon	iron	copper
3	carbon	copper	iron	aluminium
4	iron	aluminium	copper	carbon

5B Iron can be extracted from iron oxide, Fe_2O_3, by mixing the oxide with carbon and heating strongly in air.

Which row in the table below shows the name of the process and the products of the reaction?

	Name of the process	Products of the reaction
1	electrolysis	Fe, O_2 and CO_2
2	reduction	Fe and CO_2
3	electrolysis	Fe and CO_2
4	reduction	Fe, O_2 and CO_2

4.4.1.1 Metal oxides

Question 31 · continued

5C Copper is extracted from high grade ores by first heating them strongly in a furnace to obtain impure copper. This is called smelting. Pure copper is then obtained by electrolysis.

Copper is extracted from low grade ores by leaching. A solution of sulfuric acid is run through the ores to produce a solution of copper sulfate. Electrolysis of this solution gives pure copper.

An advantage of leaching over smelting is that . . .

1 leaching uses less energy.

2 leaching causes no environmental damage.

3 leaching leaves no waste.

4 leaching produces purer copper.

5D Extraction of aluminium from its ores requires a lot of energy. Aluminium obtained by recycling scrap aluminium saves about 95% of this energy.

Another advantage of recycling scrap aluminium is that . . .

1 large, new aluminium ore mines will be developed.

2 alternative metals will replace aluminium in making drinks cans.

3 deposits of aluminium ore will last longer.

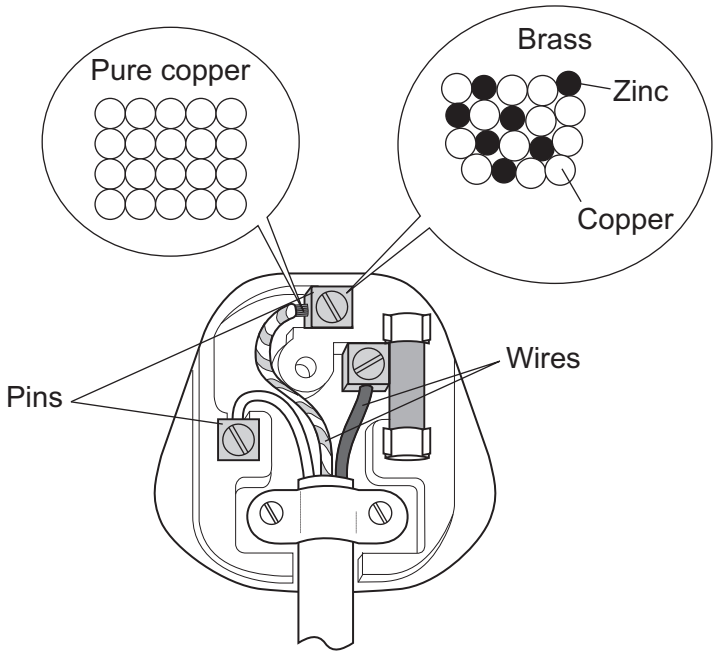
4 recycled aluminium contains other metals.

4.4.1.1 Metal oxides

Question 32

June 2011 | CHY1H | Original Q3 | Legacy

3 The diagram shows an electric plug.



3 (a) Brass is used for the pins because it is harder than pure copper. Use the particle diagrams to help you to explain why.

.....

.....

.....

.....

(2 marks)

Question 3 continues on the next page

4.4.1.1 Metal oxides

Question 32 · continued

3 (b) An ore contains a mixture of zinc carbonate and lead carbonate. Zinc and lead are produced from this ore by two reactions.

3 (b) (i) **Reaction 1**: The carbonates in the ore are converted into a mixture of zinc oxide and lead oxide.

Name this type of reaction. .....

How is this reaction done? .....

.....

(2 marks)

3 (b) (ii) **Reaction 2**: The metal oxides are mixed with carbon and heated in a furnace to produce zinc and lead.

Explain why zinc and lead are produced.

.....

.....

.....

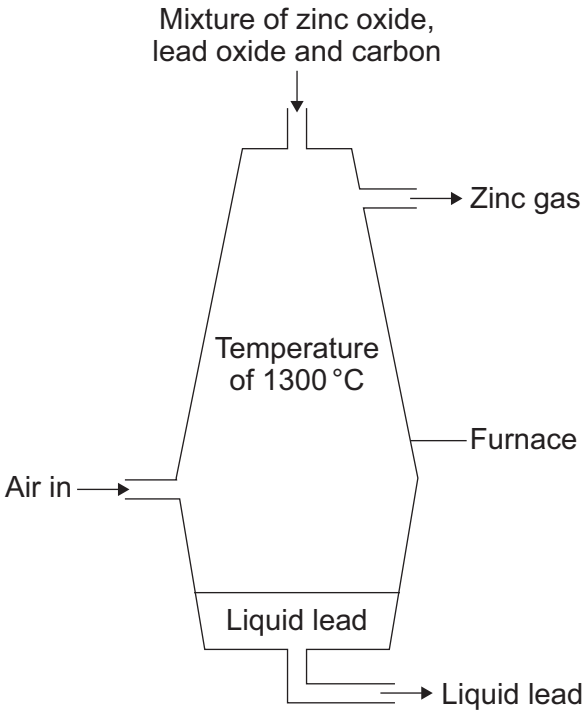
.....

(2 marks)

4.4.1.1 Metal oxides

Question 32 · continued

3 (b) (iii) The diagram represents a furnace used to produce zinc and lead from their oxides.



Metal	Melting point in °C	Boiling point in °C	Density in g per cm^3
Lead	328	1751	11.3
Zinc	420	908	7.1

Use the diagram and the information in the table to explain how zinc and lead are separated in the furnace.

.....

.....

.....

.....

.....

.....

(2 marks)

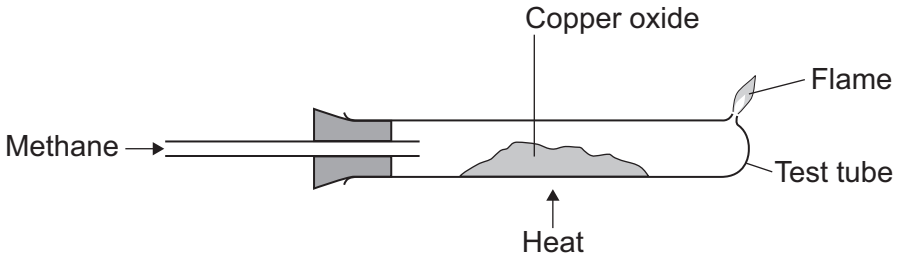
8

4.4.1.1 Metal oxides

Question 33

June 2011 | CHY2H | Original Q2 | Legacy

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



2 (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)

2 (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)

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

.....

.....

.....

Percentage of copper = ... %

(2 marks)

4.4.1.1 Metal oxides

Question 33 · continued

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

.....

.....

Mass of copper = ... g

(1 mark)

2 (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

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

.....

.....

Mean mass of copper made = ... g

(1 mark)

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

.....

.....

(1 mark)

2 (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

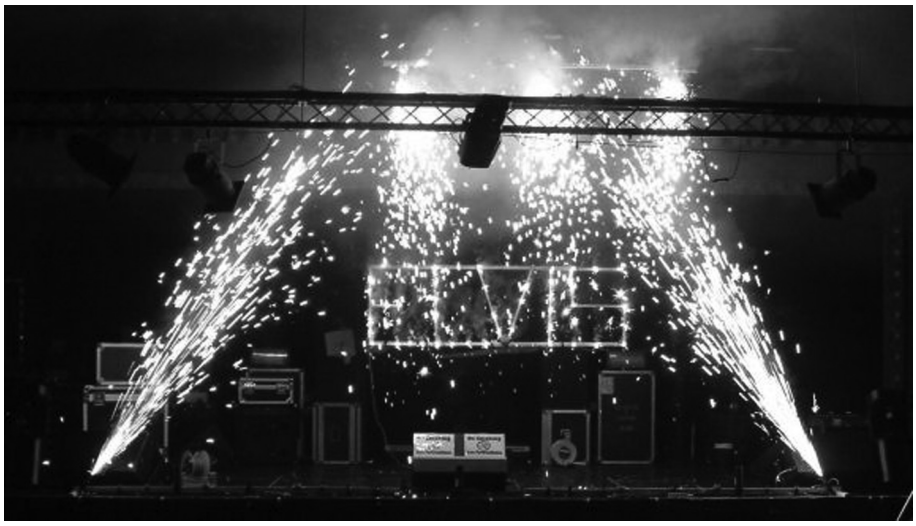
4.4.1.1 Metal oxides

Question 34

June 2011 | CHY2H | Original Q4 | Legacy

4 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.

4 (a) When aluminium burns the reaction is *exothermic*.

What is the meaning of *exothermic?*

.....

.....

(1 mark)

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

What is the name given to the heat energy needed to start a chemical reaction?

..... energy

(1 mark)

4.4.1.1 Metal oxides

Question 34 · continued

4 (c) The white smoke produced is aluminium oxide.

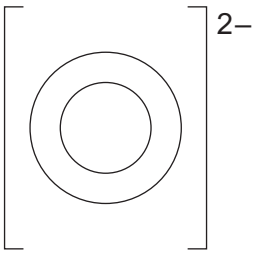
Aluminium oxide contains aluminium ions (Al^{3+}) and oxide ions (O^{2-}).

4 (c) (i) Complete the diagram to show the electronic structure of an oxide ion.

The atomic number of oxygen = 8

Use crosses (x) to represent the electrons.

oxide ion



(1 mark)

4 (c) (ii) The bonding in aluminium oxide is ionic.

What causes the aluminium ions and oxide ions to be held together strongly?

.....

.....

(1 mark)

4

4.4.1.1 Metal oxides

Question 35

November 2011 | CHY1AP | Original Q4 | Legacy

QUESTION FOUR

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.

4A 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.

4B 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.

4C 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

4D 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**

Turn over for the next question

4.4.1.1 Metal oxides

Question 36

January 2012 | CH1HP | Original Q4 | Legacy

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



4 (a) Iron is extracted by heating a mixture of iron oxide and carbon in a blast furnace.

4 (a) (i) Name this type of reaction.

.....

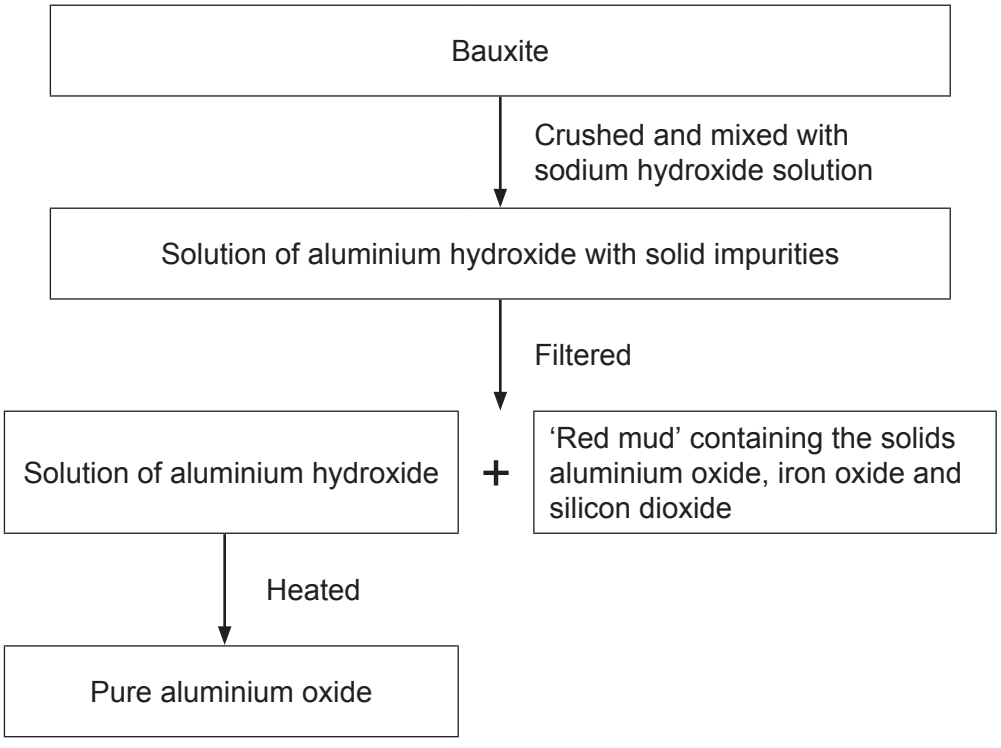
(1 mark)

4 (a) (ii) Balance the symbol equation for this reaction.

$2Fe_2O_3$ + ... C → ..... Fe + ... CO_2

(1 mark)

4 (b) Aluminium ore, bauxite, contains aluminium oxide, iron oxide and silicon dioxide.
Aluminium is extracted by electrolysis of aluminium oxide.



4.4.1.1 Metal oxides

Question 36 · continued

The 'red mud' which is dumped in very large ponds contains:

Name of solid	Percentage (%)
Aluminium oxide	10
Iron oxide	65
Silicon dioxide	25

4 (b) (i) 100 tonnes of bauxite produced 50 tonnes of pure aluminium oxide and 50 tonnes of 'red mud'.

What percentage of aluminium oxide did the bauxite contain?

.....

Answer = ... %

(1 mark)

4 (b) (ii) Apart from the solids shown in the table, name **one** other substance that would be in the 'red mud'.

.....

(1 mark)

4 (b) (iii) The purification of the aluminium oxide is usually done near to the bauxite quarries.

Suggest **one** reason why.

.....

(1 mark)

4 (c) Aluminium is used to make many things including cans.

During one year in the USA:
- 100 billion aluminium cans were sold
- 55 billion aluminium cans were recycled.

Give **one** environmental impact of recycling aluminium cans and **one** ethical or social impact of recycling aluminium cans.

Environmental .....

.....

Ethical or social .....

.....

(2 marks)

7

4.4.1.1 Metal oxides

Question 37

June 2012 | CH2HP | Original Q5 | Legacy

5 Aluminium is extracted from aluminium oxide.

5 (a) The formula of aluminium oxide is Al_2O_3

The relative formula mass (M_r) of aluminium oxide is 102.

Calculate the percentage of aluminium in aluminium oxide.

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

.....

.....

.....

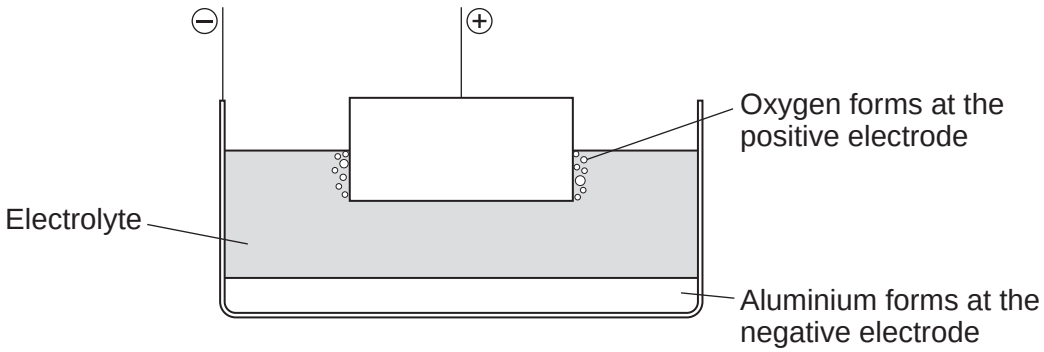
.....

Percentage of aluminium = ... %

(2 marks)

5 (b) Aluminium is extracted from aluminium oxide using electrolysis.

The diagram shows a cell used for the extraction of aluminium.



4.4.1.1 Metal oxides

Question 37 · continued

5 (b) (i) The electrolyte contains cryolite.

Explain why.

.....

.....

.....

.....

(2 marks)

5 (b) (ii) Oxygen is formed at the positive electrode. Complete and balance the equation for this reaction.

..... O^{2-} → O_2 + ...

(2 marks)

5 (b) (iii) The positive electrode in the cell is used up during the process.

Explain why.

.....

.....

.....

.....

.....

.....

(2 marks)

8

4.4.1.1 Metal oxides

Question 38

January 2013 | CH1HP | Original Q7 | Legacy

7 Iron is produced from the ore haematite (iron oxide).

Titanium is produced from the ore rutile (titanium oxide).

Iron	Titanium
Iron oxide is reacted with coke (carbon) at 1500 °C in a furnace to produce molten cast iron. Cast iron contains iron and about 4% carbon.	Titanium oxide is reacted with chlorine at 1000 °C to produce titanium chloride. Titanium chloride is cooled and collected.
↓	↓
Oxygen is blown into molten cast iron and molten recycled iron at 1500 °C in a furnace to produce low-carbon steel. Low-carbon steel contains iron and about 0.1% carbon.	Titanium chloride is reacted with magnesium at 1100 °C in a sealed reactor for 3 days. The sealed reactor contains an atmosphere of argon gas.
	↓
	The reactor is allowed to cool. The reactor is opened and the titanium is separated from the other product, magnesium chloride.

7 (a) The production of low-carbon steel uses oxygen but the production of titanium uses argon.

Explain why.

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

4.4.1.1 Metal oxides

Question 38 · continued

7 (b) There is less titanium than iron in the Earth's crust.

Apart from titanium's scarcity, explain why titanium costs much more than iron.

Use the two flow diagrams on page 16 to help you to answer this question.

.....

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

7 (c) Many chemical reactions take place in the production of both metals.

A chemical reaction in the production of iron is:

$$2\,Fe_2O_3 + 3\,C \rightarrow 4\,Fe + 3\,CO_2$$

A chemical reaction in the production of titanium is:

$$TiCl_4 + 2\,Mg \rightarrow Ti + 2\,MgCl_2$$

Titanium can be used to produce iron from iron oxide. The chemical reaction is:

$$2\,Fe_2O_3 + 3\,Ti \rightarrow 4\,Fe + 3\,TiO_2$$

Use these three reactions and the Chemistry Data Sheet to answer this question.

Suggest the position of titanium in the Reactivity Series of Metals.

Explain your answer.

.....

.....

.....

.....

.....

(2 marks)

8

4.4.1.1 Metal oxides

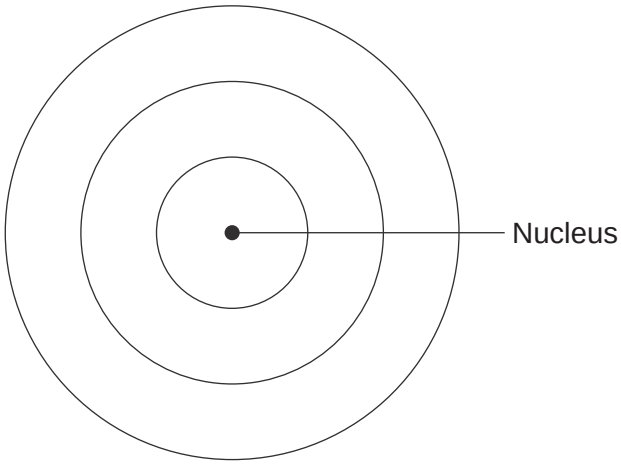
Question 39

June 2013 | CH1HP | Original Q1 | Legacy

1 Aluminium has many uses.

1 (a) An aluminium atom has 13 electrons.

1 (a) (i) Draw the electronic structure of an aluminium atom.



(1 mark)

1 (a) (ii) Name the **two** sub-atomic particles in the nucleus of an aluminium atom.

..... and .....

(1 mark)

1 (a) (iii) Why is there no overall electrical charge on an aluminium atom?

.....

.....

(1 mark)

4.4.1.1 Metal oxides

Question 39 · continued

1 (b) Rail tracks are made from steel.

Molten iron is used to weld rail tracks.

The reaction of aluminium with iron oxide is used to produce molten iron.

1 (b) (i) Balance the chemical equation for the reaction.

$$\text{.....Al} + Fe_2O_3 \longrightarrow \text{.....Fe} + Al_2O_3$$

(1 mark)

1 (b) (ii) Why does aluminium react with iron oxide?

.....

.....

(1 mark)

5

Turn over for the next question

4.4.1.1 Metal oxides

Question 40

June 2014 | CH1HP | Original Q4 | Legacy

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

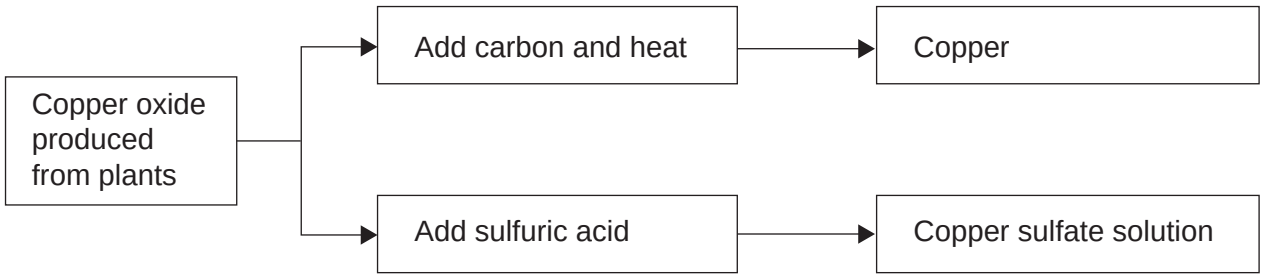
One way to extract the copper is to grow plants on the land.

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 3**.

Figure 3



4 (a) (i) Complete the sentence.

[1 mark]

Using plants to extract metals is called ..... .

4 (a) (ii) Suggest **two** reasons why copper from these areas of land is **not** extracted by smelting.

[2 marks]

.....

.....

.....

.....

.....

4 (a) (iii) Complete and balance the chemical equation for the reaction of copper oxide with carbon.

[2 marks]

.....CuO + C ⟶ ..... + CO_2

4.4.1.1 Metal oxides

Question 40 · continued

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

4 (b) (i) Use the Chemistry Data Sheet to help you to answer this question.

Give **two** reasons why scrap iron is used to displace copper.

[2 marks]

.....

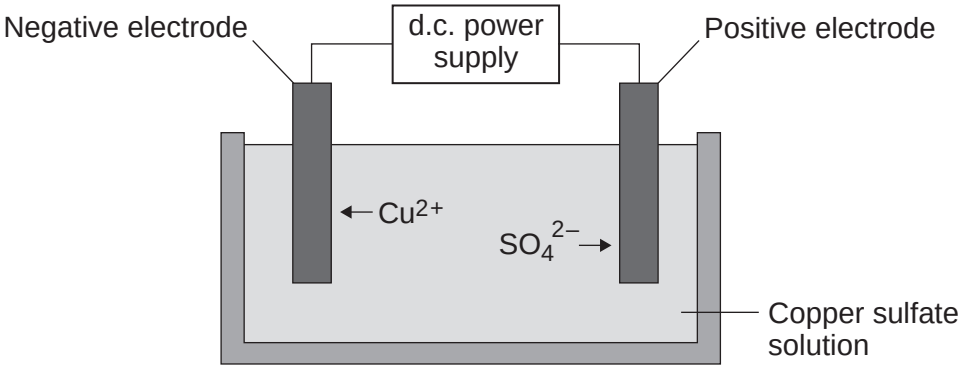
.....

.....

.....

4 (b) (ii) **Figure 4** shows the electrolysis of copper sulfate solution.

Figure 4



Describe what happens to the copper ions during electrolysis.

[2 marks]

.....

.....

.....

.....

9

4.4.1.1 Metal oxides

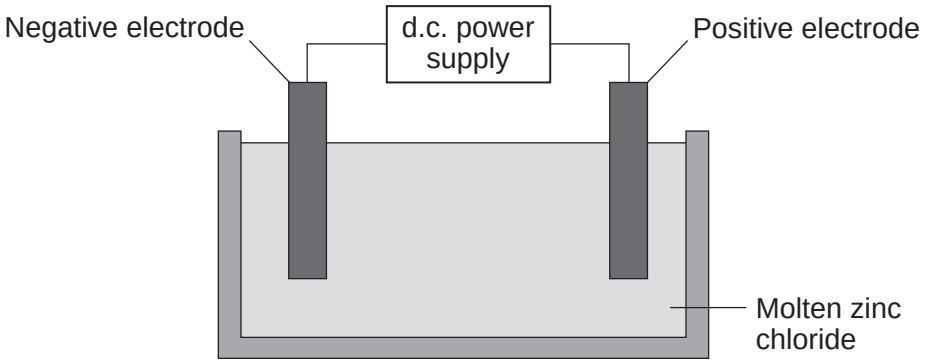
Question 41

June 2014 | CH2HP | Original Q4 | Legacy

4 This question is about zinc and magnesium.

Zinc is produced by electrolysis of molten zinc chloride, as shown in **Figure 4**.

Figure 4



4 (a) (i) Why must the zinc chloride be molten for electrolysis?

[1 mark]

.....

.....

4 (a) (ii) Describe what happens at the negative electrode.

[3 marks]

.....

.....

.....

.....

.....

.....

4 (a) (iii) Complete the half equation for the reaction at the positive electrode.

[1 mark]

..... $\longrightarrow$ Cl_2 + ... e^-

4.4.1.1 Metal oxides

Question 41 · continued

4 (b) Magnesium can be produced from magnesium oxide.

The equation for the reaction is:

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

4 (b) (i) How can you tell from the equation that the reaction is done at a high temperature?

[1 mark]

.....

.....

4 (b) (ii) This reaction to produce magnesium from magnesium oxide is **endothermic**.

What is meant by an **endothermic** reaction?

[1 mark]

.....

.....

4 (b) (iii) A company made magnesium using this reaction.

Calculate the mass of magnesium oxide needed to produce 1.2 tonnes of magnesium.

Relative atomic masses (A_r): O = 16; Mg = 24

[3 marks]

.....

.....

.....

.....

Mass of magnesium oxide needed = ... tonnes

4.4.1.1 Metal oxides

Question 41 · continued

4 (b) (iv) The company calculated that they would produce 1.2 tonnes of magnesium, but only 0.9 tonnes was produced.

Calculate the percentage yield.

[1 mark]

.....

.....

Percentage yield = ... %

4 (b) (v) Give **one** reason why the calculated yield of magnesium might not be obtained.

[1 mark]

.....

.....

12

Turn over for the next question

4.4.1.1 Metal oxides

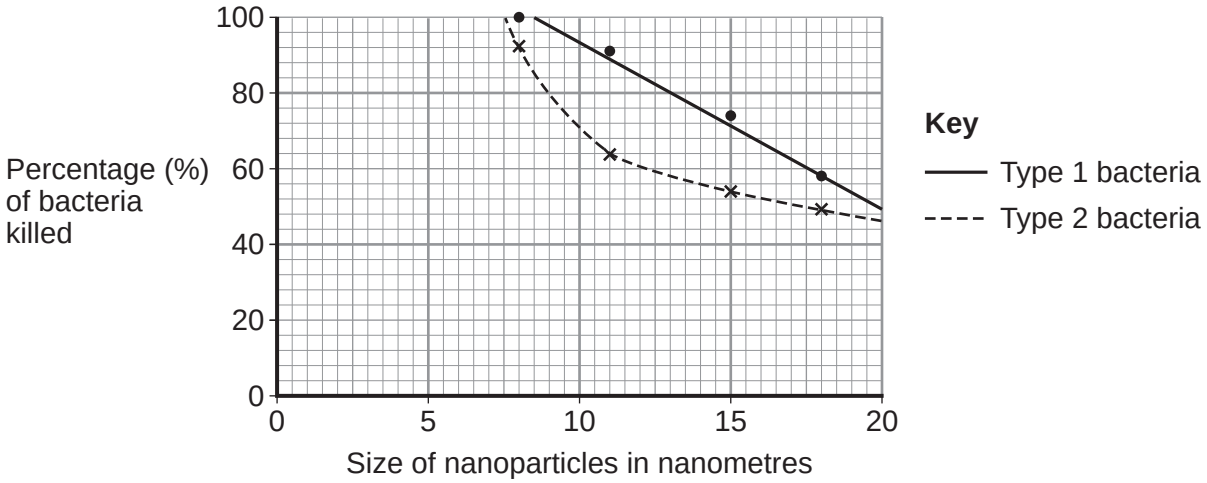
Question 42

June 2014 | CH2HP | Original Q6 | Legacy

6 Magnesium oxide nanoparticles can kill bacteria.

Figure 6 shows the percentage of bacteria killed by different sized nanoparticles.

Figure 6



6 (a) (i) Give **two** conclusions that can be made from **Figure 6**.

[2 marks]

.....

.....

.....

.....

.....

.....

6 (a) (ii) Points are plotted for only some sizes of nanoparticles.

Would collecting and plotting data for more sizes of nanoparticles improve the conclusions?

Give a reason for your answer.

[1 mark]

.....

.....

4.4.1.1 Metal oxides

Question 42 · continued

6 (b) Magnesium oxide contains magnesium ions (Mg^{2+}) and oxide ions (O^{2-}).

Describe, as fully as you can, what happens when magnesium atoms react with oxygen atoms to produce magnesium oxide.

[4 marks]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

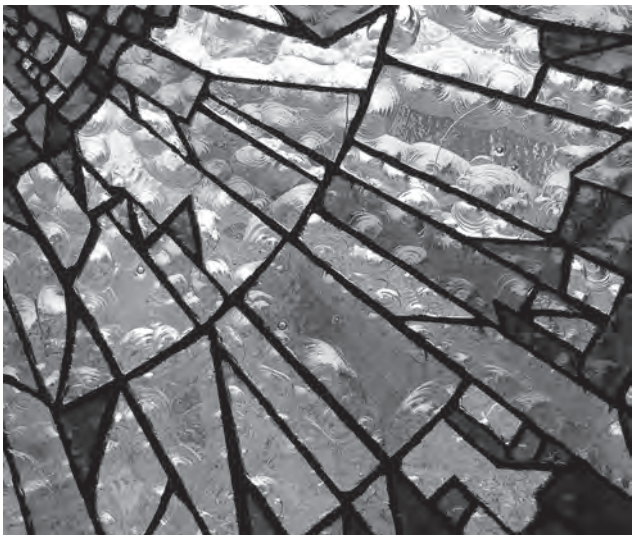
7

4.4.1.1 Metal oxides

Question 43

June 2014 | CH2HP | Original Q7 | Legacy

7 Glass is made from silicon dioxide.



7 (a) Silicon dioxide has a very high melting point.

Other substances are added to silicon dioxide to make glass. Glass melts at a lower temperature than silicon dioxide.

Suggest why.

[1 mark]

.....

.....

7 (b) Sodium oxide is one of the substances added to silicon dioxide to make glass.

7 (b) (i) Sodium oxide contains Na^+ ions and O^{2-} ions.

Give the formula of sodium oxide.

[1 mark]

.....

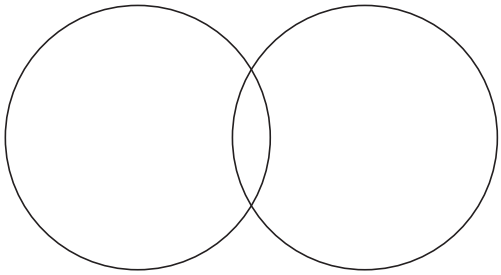
4.4.1.1 Metal oxides

Question 43 · continued

7 (b) (ii) Sodium oxide is made by heating sodium metal in oxygen gas.

Complete the diagram to show the outer electrons in an oxygen molecule (O_2).

[2 marks]



7 (c) Glass can be coloured using tiny particles of gold. Gold is a metal.

Describe the structure of a metal.

[3 marks]

.....

.....

.....

.....

.....

.....

7

4.4.1.1 Metal oxides

Question 44

June 2015 | CH2HP | Original Q5 | Legacy

5 This question is about compounds.

5 (a) **Table 2** gives information about the solubility of some compounds.

Table 2

Soluble compounds
All potassium and sodium salts
All nitrates
Chlorides, bromides and iodides, except those of silver and lead

Use information from **Table 2** to answer these questions.

5 (a) (i) Name a soluble compound that contains silver ions.

[1 mark]

.....

5 (a) (ii) Name a soluble compound that contains carbonate ions.

[1 mark]

.....

5 (b) Metal oxides react with acids to make salts.

What type of compound is a metal oxide?

[1 mark]

.....

4.4.1.1 Metal oxides

Question 44 · continued

5 (c) Lead nitrate solution is produced by reacting lead oxide with nitric acid.

5 (c) (i) State how solid lead nitrate can be obtained from lead nitrate solution.

[1 mark]

.....

.....

5 (c) (ii) Balance the equation for the reaction.

[1 mark]

$$PbO + HNO_3 \longrightarrow Pb(NO_3)_2 + H_2O$$

5 (c) (iii) Give the total number of atoms in the formula $Pb(NO_3)_2$

[1 mark]

.....

5 (d) An oxide of lead that does **not** have the formula PbO contains 6.21 g of lead and 0.72 g of oxygen.

Calculate the empirical formula of this lead oxide.

Relative atomic masses (A_r): O = 16; Pb = 207

You must show your working to gain full marks.

[4 marks]

.....

.....

.....

.....

.....

.....

Empirical formula = ...

10

4.4.1.1 Metal oxides

Question 45

June 2016 | CH1HP | Original Q3 | Legacy

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

Some ores contain metal carbonates and some ores contain metal oxides.

3 (a) (i) Name the type of reaction that happens when a metal carbonate is heated.

[1 mark]

_____

3 (a) (ii) Which solid product is formed when copper carbonate is heated?

[1 mark]

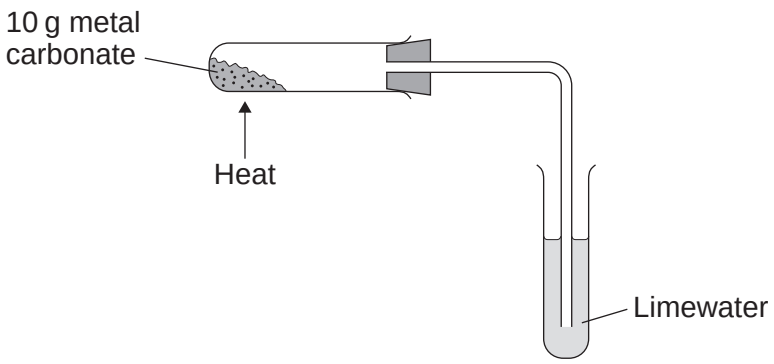
Tick (✓) **one** box.

- copper ☐
- copper nitrate ☐
- copper oxide ☐
- copper sulfide ☐

3 (b) A student investigated heating four metal carbonates.

Figure 4 shows the apparatus used.

Figure 4



Question 45 · continued

The student heated each metal carbonate for five minutes.

Table 3 shows the results.

Table 3

Metal carbonate	Mass of metal carbonate at start in g	Mass of solid after heating for 5 minutes in g	Observations
Copper carbonate	10.0	6.9	Limewater turns cloudy
Magnesium carbonate	10.0	9.1	Limewater turns cloudy
Potassium carbonate	10.0	10.0	Limewater does not turn cloudy
Zinc carbonate	10.0	8.3	Limewater turns cloudy

3 (b) (i) Explain the results for potassium carbonate.

[3 marks]

3 (b) (ii) Suggest how the reactivity series can be used to predict which metal carbonate reacts most easily when heated.

[2 marks]

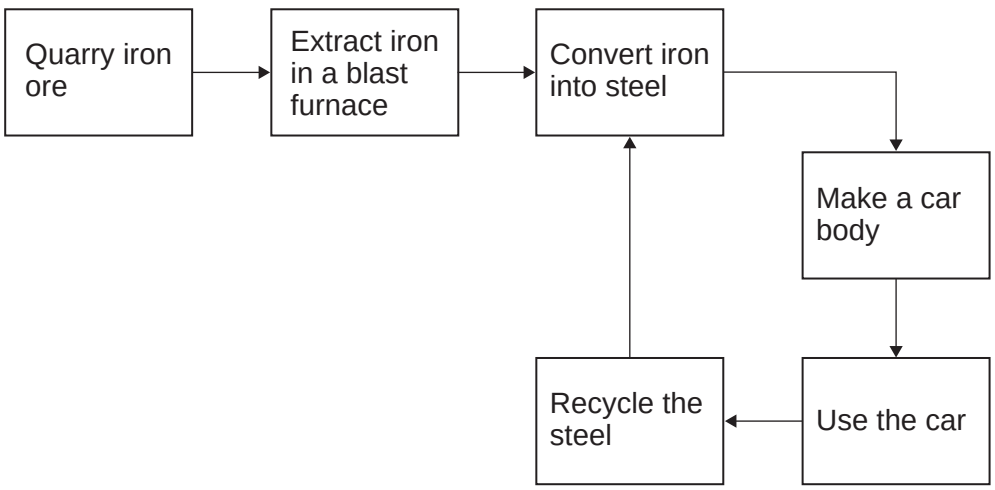
Question 3 continues on the next page

4.4.1.1 Metal oxides

Question 45 · continued

3 (c) **Figure 5** shows a simple life cycle of a car body.

Figure 5



3 (c) (i) Complete the sentence.

[1 mark]

Iron ores must contain enough iron to _____

_____

3 (c) (ii) Some iron ores contain iron oxide (Fe_2O_3).

Complete and balance the equation for a reaction to produce iron from iron oxide.

[2 marks]

_____ Fe_2O_3 + _____ C ⟶ _____ + _____ CO_2

3 (c) (iii) Give **two** reasons why iron produced in a blast furnace is converted into steel.

[2 marks]

_____

_____

_____

_____

4.4.1.1 Metal oxides

Question 45 · continued

3 (c) (iv) When a car reaches the end of its useful life, the car body can be:

- recycled
- reused
- sent to landfill.

Give **three** reasons why a steel car body should be recycled and **not** reused or sent to landfill.

[3 marks]

15

4.4.1.1 Metal oxides

Question 46

June 2017 | CH1HP | Original Q1 | Legacy

1 Elements are made of atoms.

1 (a) **Table 1** shows the atomic numbers and mass numbers of three atoms.

Table 1

Atom	Atomic number	Mass number
1	12	24
2	12	25
3	12	26

1 (a) (i) Suggest, in terms of the number of subatomic particles, why the atomic numbers of the three atoms are the same.

[1 mark]

_____

_____

1 (a) (ii) Explain, in terms of the number of subatomic particles, why the mass numbers of the three atoms are different.

[2 marks]

_____

_____

_____

1 (b) When elements react, their atoms join with other atoms to form compounds.

Sulfuric acid, H_2SO_4, is a compound.

1 (b) (i) How many elements are in the formula H_2SO_4?

[1 mark]

_____

1 (b) (ii) How many atoms are in the formula H_2SO_4?

[1 mark]

_____

4.4.1.1 Metal oxides

Question 46 · continued

1 (c) Sulfuric acid reacts with metal oxides.

$$\underset{\text{copper oxide}}{CuO} + \underset{\text{sulfuric acid}}{H_2SO_4} \longrightarrow \underset{\text{copper sulfate}}{CuSO_4} + \underset{\text{water}}{H_2O}$$

In a reaction, 159 g of copper oxide reacts with 196 g of sulfuric acid.

What is the mass of the products?

[1 mark]

Tick (✓) **one** box.

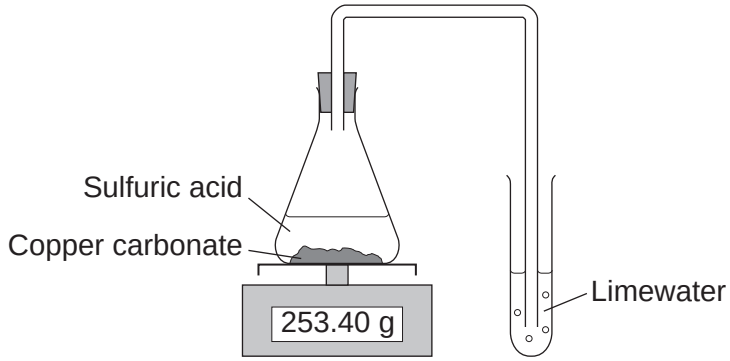
Mass of copper sulfate in g	Mass of water in g	Tick (✓)
30	7	
159	36	
196	18	
319	36	

4.4.1.1 Metal oxides

Question 46 · continued

1 (d) **Figure 1** shows apparatus used to investigate the reaction of sulfuric acid with copper carbonate.

Figure 1



Describe and explain the changes seen during the reaction.

[3 marks]

9

4.4.1.1 Metal oxides

Question 47

June 2017 | CH2HP | Original Q3 | Legacy

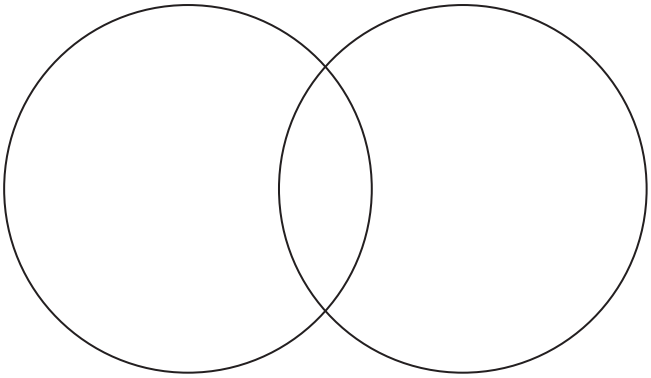
3 This question is about oxygen and substances containing oxygen.

3 (a) (i) Complete **Figure 4** to show the arrangement of the outer shell electrons in an oxygen molecule.

Use dots (•) and crosses (×) to represent the electrons.

[2 marks]

Figure 4



3 (a) (ii) Name the type of bonding in an oxygen molecule.

[1 mark]

_____

3 (a) (iii) Explain why oxygen has a low boiling point.

[2 marks]

_____

_____

_____

_____

4.4.1.1 Metal oxides

Question 47 · continued

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

3 (b) (i) **Balance** the equation for the reaction.

[1 mark]

$$Mg + O_2 \longrightarrow MgO$$

3 (b) (ii) Magnesium oxide contains magnesium ions (Mg^{2+}) and oxide ions (O^{2-}).

Describe what happens, in terms of electrons, when magnesium atoms react with oxygen atoms to produce magnesium oxide.

[3 marks]

3 (b) (iii) Magnesium oxide nanoparticles can be made.

What are nanoparticles?

[1 mark]

Question 3 continues on the next page

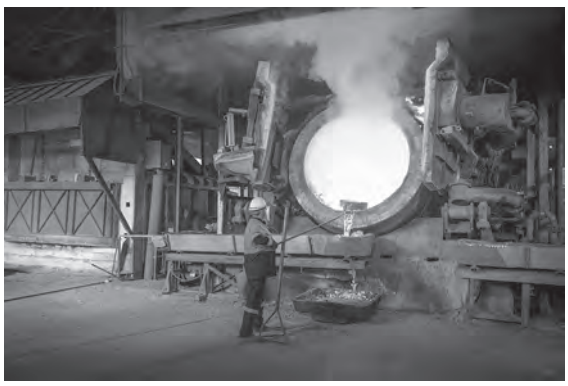
4.4.1.1 Metal oxides

Question 47 · continued

3 (c) **Figure 5** shows a furnace lined with silicon dioxide (SiO_2).

The temperature in the furnace is 1500 °C.

Figure 5



Explain, in terms of structure and bonding, why silicon dioxide is used to line furnaces.

[3 marks]

13

4.4.1.1 Metal oxides

Question 48

June 2017 | CH2HP | Original Q4 | Legacy

4 This question is about sulfuric acid (H_2SO_4) and ethene.

Sulfuric acid is used to produce copper sulfate ($CuSO_4$).

The equation for the reaction is:

$$CuO(s) + H_2SO_4(aq) \longrightarrow CuSO_4(aq) + H_2O(l)$$

4 (a) Describe a method for making copper sulfate crystals from copper oxide and sulfuric acid.

[4 marks]

4 (b) Calculate the mass of copper oxide required to produce 24.95 g of copper sulfate crystals ($CuSO_4.5H_2O$).

Relative formula mass (M_r) of copper sulfate crystals = 249.5

Relative atomic masses (A_r): O = 16; Cu = 63.5

[3 marks]

Mass of copper oxide = _____ g

4.4.1.1 Metal oxides

Question 48 · continued

4 (c) Ethene and sulfuric acid are used to make many substances.

4 (c) (i) **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	620	3 100	2 500
E	460	1 500	4 200
F	310	650	6 700

How does the wealth of countries relate to their production of ethene and sulfuric acid?

[2 marks]

4 (c) (ii) Suggest why the use of ethene has increased in the last 50 years.

[1 mark]

10

4.4.1.1 Metal oxides

Question 49

June 2018 | 8462/1H | Original Q1

0 1 Soluble salts are formed by reacting metal oxides with acids.

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

[1 mark]

0 1 . 2 Calcium nitrate contains the ions Ca^{2+} and NO_3^-

Give the formula of calcium nitrate.

[1 mark]

0 1 . 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 50

June 2019 | 8462/1H | Original Q5

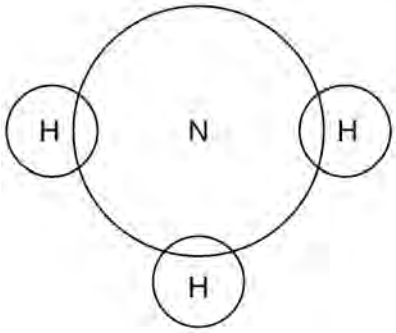
0 5 This question is about ammonia, NH_3

0 5 . 1 Complete the dot and cross diagram for the ammonia molecule shown in **Figure 6**.

Show only the electrons in the outer shell of each atom.

[2 marks]

Figure 6



0 5 . 2 Give **one** limitation of using a dot and cross diagram to represent an ammonia molecule.

[1 mark]

0 5 . 3 Explain why ammonia has a low boiling point.

You should refer to structure and bonding in your answer.

[3 marks]

Question 50 · continued

Ammonia reacts with oxygen in the presence of a metal oxide catalyst to produce nitrogen and water.

0 5 . 4 Which metal oxide is most likely to be a catalyst for this reaction?

[1 mark]

Tick (✓) **one** box.

- CaO ☐
- Cr_2O_3 ☐
- MgO ☐
- Na_2O ☐

Figure 7 shows the displayed formula equation for the reaction.

Figure 7

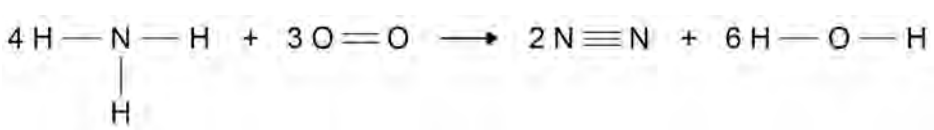


Table 3 shows some bond energies.

Table 3

Bond	N — H	O = O	N ≡ N	O — H
Bond energy in kJ/mol	391	498	945	464

4.4.1.1 Metal oxides

Question 50 · continued

0 5 . 5 Calculate the overall energy change for the reaction.

Use **Figure 7** and **Table 3**.

[3 marks]

Overall energy change = _____ kJ

0 5 . 6 Explain why the reaction between ammonia and oxygen is exothermic.

Use values from your calculation in Question **05.5**

[2 marks]

Question 5 continues on the next page

4.4.1.1 Metal oxides

Question 50 · continued

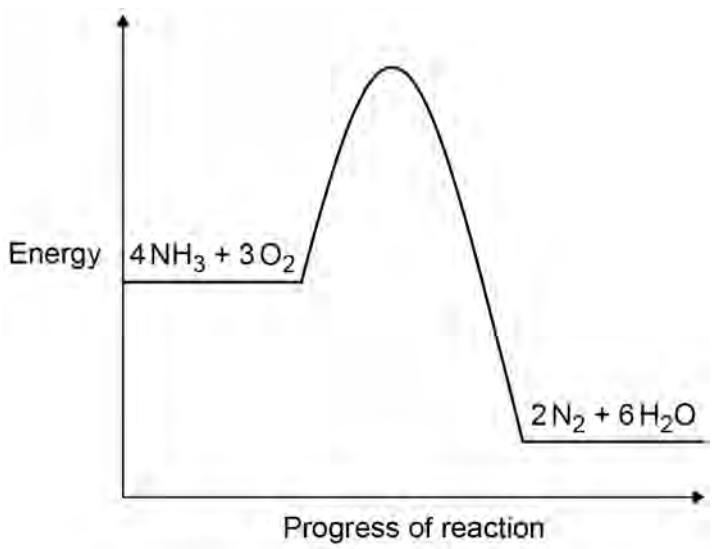
0 5 . 7 **Figure 8** shows the reaction profile for the reaction between ammonia and oxygen.

Complete **Figure 8** by labelling the:

- activation energy
- overall energy change.

[2 marks]

Figure 8



14

4.4.1.1 Metal oxides

Question 51

June 2019 | 8462/1H | Original Q7

0 7 This question is about electrolysis.

Aluminium is produced by electrolysing a molten mixture of aluminium oxide and cryolite.

0 7 . 1 Explain why a mixture is used as the electrolyte instead of using only aluminium oxide.

[2 marks]

0 7 . 2 What happens at the negative electrode during the production of aluminium?

[1 mark]

Tick (✓) **one** box.

- Aluminium atoms gain electrons. ☐
- Aluminium atoms lose electrons. ☐
- Aluminium ions gain electrons. ☐
- Aluminium ions lose electrons. ☐

0 7 . 3 Oxygen is produced at the positive electrode.

Complete the balanced half-equation for the process at the positive electrode.

[2 marks]

$\rightarrow \quad O_2 \quad +$

4.4.1.1 Metal oxides

Question 51 · continued

0 7 . 4 Explain why the positive electrode must be continually replaced.

[3 marks]

0 7 . 5 The overall equation for the electrolysis of aluminium oxide is:

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

Calculate the mass of oxygen produced when 2000 kg of aluminium oxide is completely electrolysed.

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

[4 marks]

Mass of oxygen = _____ kg

4.4.1.1 Metal oxides

Question 51 · continued

Sodium metal and chlorine gas are produced by the electrolysis of molten sodium chloride.

0 7 . 6 Explain why sodium chloride solution **cannot** be used as the electrolyte to produce sodium metal.

[2 marks]

0 7 . 7 Calculate the volume of 150 kg of chlorine gas at room temperature and pressure.

The volume of one mole of any gas at room temperature and pressure is 24.0 dm^3

Relative formula mass (M_r): Cl_2 = 71

[2 marks]

Volume = _____ dm^3

16

4.4.1.1 Metal oxides

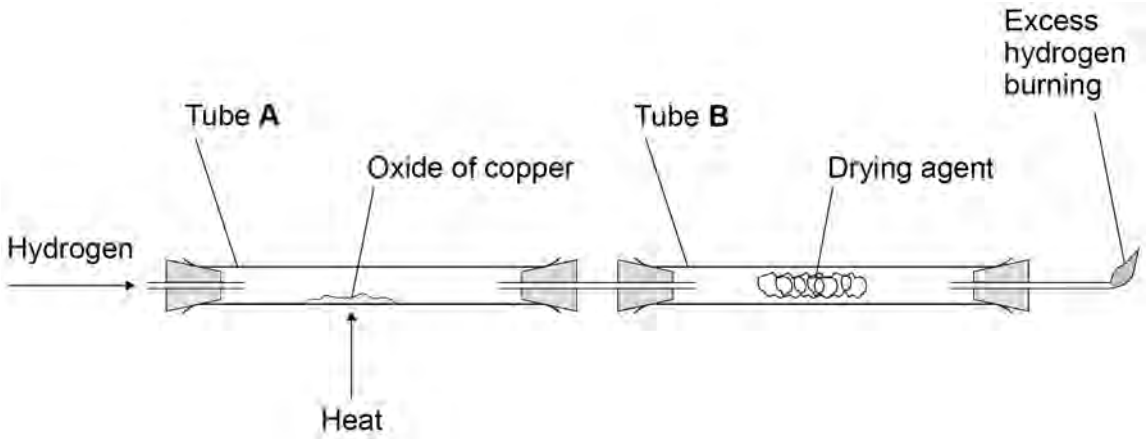
Question 52

0 8 Copper forms two oxides, Cu_2O and CuO

A teacher investigated an oxide of copper.

Figure 10 shows the apparatus.

Figure 10



This is the method used.

1. Weigh empty tube **A**.
2. Add some of the oxide of copper to tube **A**.
3. Weigh tube **A** and the oxide of copper.
4. Weigh tube **B** and drying agent.
5. Pass hydrogen through the apparatus and light the flame at the end.
6. Heat tube **A** for 2 minutes.
7. Reweigh tube **A** and contents.
8. Repeat steps 5 to 7 until the mass no longer changes.
9. Reweigh tube **B** and contents.
10. Repeat steps 1 to 9 with different masses of the oxide of copper.

4.4.1.1 Metal oxides

Question 52 · continued

0 8 . 1 Suggest **one** reason why step 8 is needed.

[1 mark]

0 8 . 2 Explain why the excess hydrogen must be burned off.

[2 marks]

Question 8 continues on the next page

4.4.1.1 Metal oxides

Question 52 · continued

Figure 10 is repeated here.

Figure 10

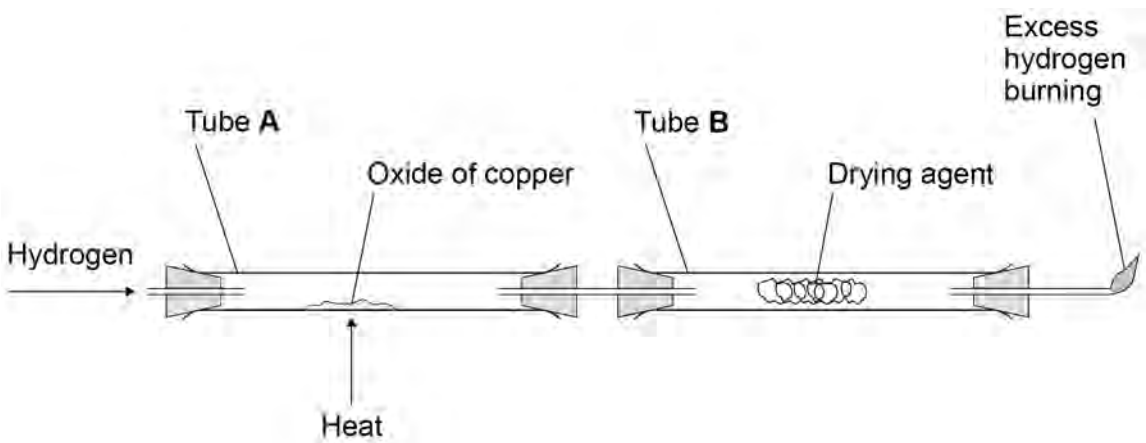


Table 5 shows the teacher's results.

Table 5

	Mass in g
Tube **A** empty	105.72
Tube **A** and oxide of copper before heating	115.47
Tube **A** and contents after 2 minutes	114.62
Tube **A** and contents after 4 minutes	114.38
Tube **A** and contents after 6 minutes	114.38
Tube **B** and contents at start	120.93
Tube **B** and contents at end	123.38

When an oxide of copper is heated in a stream of hydrogen, the word equation for the reaction is:

copper oxide + hydrogen → copper + water

4.4.1.1 Metal oxides

Question 52 · continued

0 8 . 3 Determine the mass of copper and the mass of water produced in this experiment.

Use **Table 5**.

[2 marks]

Mass of copper = _____ g

Mass of water = _____ g

0 8 . 4 The teacher repeated the experiment with a different sample of the oxide of copper.

The teacher found that the oxide of copper produced 2.54 g of copper and 0.72 g of water.

Two possible equations for the reaction are:

Equation 1: $Cu_2O + H_2 \rightarrow 2Cu + H_2O$

Equation 2: $CuO + H_2 \rightarrow Cu + H_2O$

Determine which is the correct equation for the reaction in the teacher's experiment.

Relative atomic masses (A_r): H = 1 O = 16 Cu = 63.5

[3 marks]

8

4.4.1.1 Metal oxides

Question 53

November 2020 | 8462/1H | Original Q1

0 1 This question is about structure and bonding.

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

[2 marks]

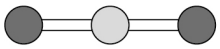
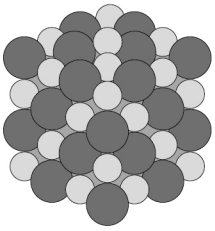
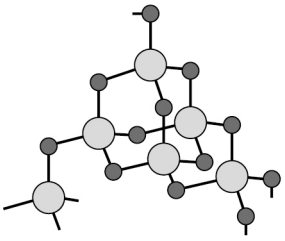
Tick (✓) **two** boxes.

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

0 1 . 2 **Table 1** shows the structures of three compounds.

Table 1

Diagrams not to scale

Compound	Structure
Carbon dioxide	
Magnesium oxide	
Silicon dioxide	

4.4.1.1 Metal oxides

Question 53 · 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 54

November 2020 | 8462/1H | Original Q6

0 6 This question is about displacement reactions.

0 6 . 1 The displacement reaction between aluminium and iron oxide has a high activation energy.

What is meant by 'activation energy'?

[1 mark]

0 6 . 2 A mixture contains 1.00 kg of aluminium and 3.00 kg of iron oxide.

The equation for the reaction is:

$$2\,Al + Fe_2O_3 \rightarrow 2\,Fe + Al_2O_3$$

Show that aluminium is the limiting reactant.

Relative atomic masses (A_r): O = 16 Al = 27 Fe = 56

[4 marks]

4.4.1.1 Metal oxides

Question 54 · continued

Magnesium displaces zinc from zinc sulfate solution.

0 6 . 3 Complete the ionic equation for the reaction.

You should include state symbols.

[2 marks]

$$Mg(s) + Zn^{2+}(aq) \rightarrow _____ + _____$$

0 6 . 4 Explain why the reaction between magnesium atoms and zinc ions is both oxidation and reduction.

[2 marks]

9

4.4.1.1 Metal oxides

Question 55

November 2021 | 8462/1H | Original Q3

0 3 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:

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

0 3 . 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** = _____

0 3 . 2 Identify element **R**.

You should use:

- your answer to **question 03.1**
- the periodic table.

[1 mark]

Identity of **R** = _____

4.4.1.1 Metal oxides

Question 55 · continued

0 3 . 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 3 continues on the next page

4.4.1.1 Metal oxides

0 3 . 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 2 shows information about three possible methods to extract tungsten from tungsten oxide.

Table 2

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 56

November 2021 | 8462/1H | Original Q4

0 4 This question is about Group 1 elements.

0 4 . 1 Give **two** observations you could make when a small piece of potassium is added to water.

[2 marks]

1 _____

_____

2 _____

_____

0 4 . 2 Complete the equation for the reaction of potassium with water.

You should balance the equation.

[2 marks]

$$K + \qquad H_2O \rightarrow \qquad +$$

0 4 . 3 Explain why the reactivity of elements changes going down Group 1.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

_____

_____

4.4.1.1 Metal oxides

Question 56 · continued

Sodium reacts with oxygen to produce the ionic compound sodium oxide.

Oxygen is a Group 6 element.

0 4 . 4 Draw a dot and cross diagram to show what happens when atoms of sodium and oxygen react to produce sodium oxide.

[4 marks]

Diagram

4.4.1.1 Metal oxides

Question 56 · continued

0 4 . 5 Why is oxygen described as being reduced in the reaction between sodium and oxygen?

[1 mark]

0 4 . 6 Explain why sodium oxide has a high melting point.

[3 marks]

16

4.4.1.1 Metal oxides

Question 57

November 2021 | 8462/1H | Original Q5

0 5 This question is about salts.

0 5 . 1 Name the salt produced by the neutralisation of hydrochloric acid with potassium hydroxide.

[1 mark]

_____

0 5 . 2 Write an ionic equation for the neutralisation of hydrochloric acid with potassium hydroxide.

[1 mark]

_____ + _____ → _____

0 5 . 3 Soluble salts can be produced by reacting dilute hydrochloric acid with an insoluble solid.

Copper, copper carbonate and copper oxide are insoluble solids.

Which of these insoluble solids can be used to make a copper salt by reacting the solid with dilute hydrochloric acid?

[1 mark]

Tick (✓) **one** box.

- Copper and copper carbonate only ☐
- Copper and copper oxide only ☐
- Copper carbonate and copper oxide only ☐
- Copper, copper carbonate and copper oxide ☐

4.4.1.1 Metal oxides

Question 57 · continued

A student makes crystals of magnesium sulfate.

This is the method used.

1. Add sulfuric acid to a beaker.
2. Warm the sulfuric acid.
3. Add a spatula of magnesium oxide to the beaker.
4. Stir the mixture.
5. Repeat steps 3 and 4 until there is magnesium oxide remaining in the beaker.
6. Filter the mixture.
7. Evaporate the filtrate gently until crystals start to form.
8. Leave the solution to finish crystallising.

0 5 . 4 Give **one** reason for:

- step 2
- step 5
- step 6.

[3 marks]

Step 2 _____

_____

Step 5 _____

_____

Step 6 _____

_____

0 5 . 5 How should the filtrate be evaporated gently in **step 7**?

[1 mark]

_____

_____

4.4.1.1 Metal oxides

Question 57 · continued

0 5 . 6 Iron chloride is produced by heating iron in chlorine gas.

The equation for the reaction is:

$$2\,Fe + 3\,Cl_2 \rightarrow 2\,FeCl_3$$

Calculate the volume of chlorine needed to react with 14 g of iron.

You should calculate:

- the number of moles of iron used
- the number of moles of chlorine that react with 14 g of iron
- the volume of chlorine needed.

Relative atomic mass (A_r): Fe = 56

The volume of 1 mole of gas = 24 dm^3

[3 marks]

Volume of chlorine = _____ dm^3

10

4.4.1.1 Metal oxides

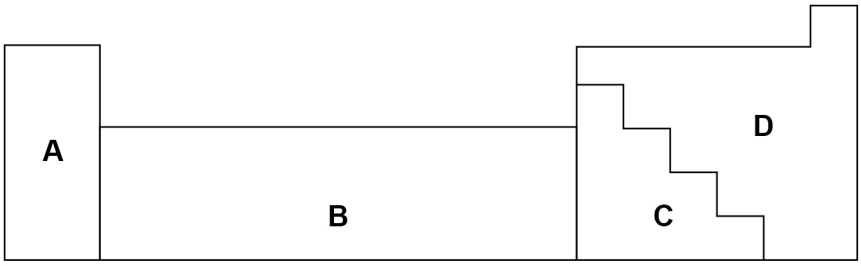
Question 58

June 2022 | 8462/1H | Original Q1

0 1 This question is about metals and non-metals.

Figure 1 shows an outline of part of the periodic table.

Figure 1



0 1 . 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 1** is most likely to contain element **Q**?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 1 . 2 Element **R** forms ions of formula R^{2+} and R^{3+}

Which section of the periodic table in **Figure 1** is most likely to contain element **R**?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 1 . 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

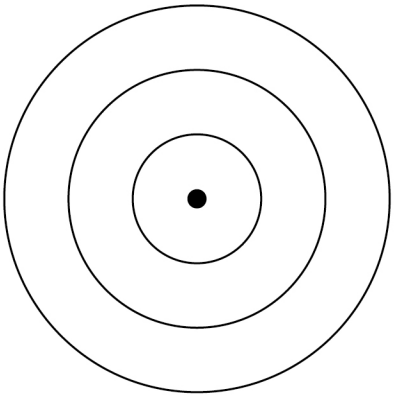
Question 58 · continued

0 1 . 4 Complete **Figure 2** to show the electronic structure of an aluminium atom.

Use the periodic table.

[1 mark]

Figure 2



0 1 . 5 Aluminium is a metal.

Describe how metals conduct electricity.

Answer in terms of electrons.

[3 marks]

0 1 . 6 Name the type of bonding in compounds formed between metals and non-metals.

[1 mark]

4.4.1.1 Metal oxides

Question 58 · continued

0 1 . 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 59

June 2022 | 8462/1H | Original Q7

0 7 This question is about silicon and compounds of silicon.

0 7 . 1 The reactivity series sometimes includes non-metals such as carbon, hydrogen and silicon.

Silicon can be extracted by reducing silicon dioxide with different substances.

The equation for one possible reaction is:

$$2\,C(s) + SiO_2(s) \rightarrow Si(s) + 2\,CO(g)$$

Explain what this reaction shows about the position of silicon in the reactivity series.

[2 marks]

0 7 . 2 Aluminium also reduces silicon dioxide.

Carbon is used rather than aluminium to reduce silicon dioxide because carbon is cheaper than aluminium.

Carbon can be obtained by heating coal.

Aluminium is obtained from aluminium oxide.

Explain why aluminium is more expensive than carbon.

[2 marks]

4.4.1.1 Metal oxides

Question 59 · continued

Magnesium also reduces silicon dioxide.

The equation for the reaction is:

$$2\,Mg(s) + SiO_2(s) \rightarrow Si(s) + 2\,MgO(s)$$

0 7 . 3 Give **one** reason why the products are difficult to separate if magnesium is used to reduce silicon dioxide.

[1 mark]

0 7 . 4 Calculate the minimum mass in grams of magnesium needed to completely reduce 1.2 kg of silicon dioxide.

Relative atomic masses (A_r): O = 16 Mg = 24 Si = 28

[5 marks]

Minimum mass of magnesium = _____ g

4.4.1.1 Metal oxides

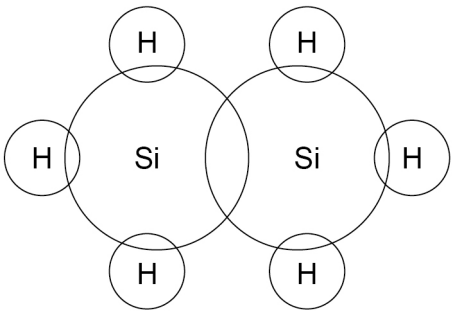
Question 59 · continued

Si_2H_6 is a covalent compound of silicon and hydrogen.

0 7 . 5 Complete **Figure 9** to show the outer shell electrons in a molecule of Si_2H_6

[1 mark]

Figure 9



0 7 . 6 Si_2H_6 reacts with oxygen.

The equation for the reaction is:

$$2\,Si_2H_6(g) + 7\,O_2(g) \rightarrow 4\,SiO_2(s) + 6\,H_2O(g)$$

30 cm^3 of Si_2H_6 is reacted with 150 cm^3 (an excess) of oxygen.

Calculate the total volume of gases present after the reaction.

All volumes of gases are measured at the same temperature and pressure.

[4 marks]

Volume of gases = _____ cm^3

15

4.4.1.1 Metal oxides

Question 60

June 2023 | 8462/1H | Original Q7

0 7 This question is about electrolysis.

Aluminium is manufactured by electrolysing a molten mixture of aluminium oxide (Al_2O_3) and cryolite (Na_3AlF_6).

0 7 . 1 Complete the half equation for the reaction occurring at the negative electrode.

[1 mark]

$$Al^{3+} + ____ e^- \rightarrow Al$$

0 7 . 2 Cryolite contains Na^+ ions as well as Al^{3+} ions.

Suggest **one** reason why sodium is **not** a product of the electrolysis.

[1 mark]

Question 7 continues on the next page

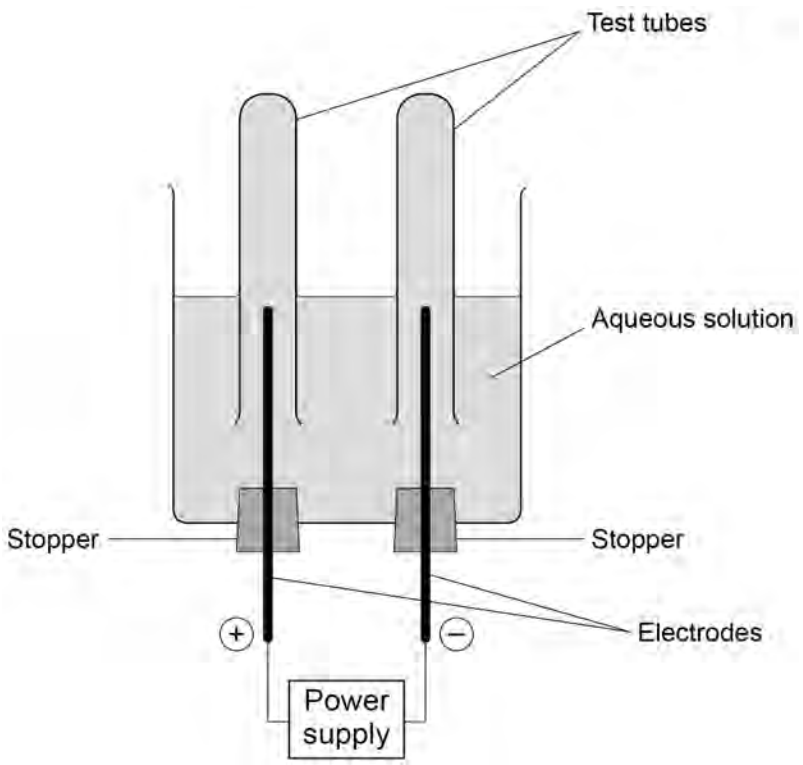
4.4.1.1 Metal oxides

Question 60 · continued

A student investigated the electrolysis of an aqueous solution of a different compound.

Figure 7 shows the apparatus.

Figure 7



4.4.1.1 Metal oxides

Question 60 · continued

Hydrogen was produced at the negative electrode and oxygen was produced at the positive electrode.

0 7 . 3 Explain how oxygen was produced from water during the electrolysis of this aqueous solution.

[4 marks]

0 7 . 4 The student compared the volumes of the two gases collected.

How can the student change the apparatus in **Figure 7** to compare the volumes of the two gases produced more accurately?

Give **one** reason for your answer.

[2 marks]

Change _____

Reason _____

0 7 . 5 The overall equation for the reaction is:

$$2\,H_2O(l) \rightarrow 2\,H_2(g) + O_2(g)$$

What is the volume of oxygen produced when 20 cm^3 of hydrogen has been produced?

[1 mark]

Tick (✓) **one** box.

10 cm^3 ☐ 20 cm^3 ☐ 30 cm^3 ☐ 40 cm^3 ☐

9

4.4.1.1 Metal oxides

Question 61

June 2023 | 8462/1H | Original Q9

0 9 This question is about displacement reactions.

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

The equation for the reaction is:

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

0 9 . 1 Which substance in the equation is reduced?

Give **one** reason for your answer.

Answer in terms of oxygen.

[2 marks]

Substance reduced _____

Reason _____

_____

0 9 . 2 Which expression shows how to calculate the mass of carbon needed to produce 1 mole of iron from iron oxide?

Relative atomic mass (A_r): C = 12

[1 mark]

Tick (✓) **one** box.

$\frac{1}{3} \times 12$ g ☐

$\frac{3}{2} \times 12$ g ☐

1×12 g ☐

3×12 g ☐

Question 9 continues on the next page

Question 61 · continued

A student investigated displacement reactions of four different metals represented by **A**, **B**, **C** and **D**.

A, **B**, **C** and **D** are **not** the actual chemical symbols for the metals.

The student:

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

Table 6 shows information about three of the reaction mixtures.

Table 6

Reaction	Metal	Metal nitrate solution	Equation
1	**A**	**B**NO_3	**A** + 2**B**NO_3 → 2**B** + **A**$(NO_3)_2$
2	**C**	**A**$(NO_3)_2$	2**C** + 3**A**$(NO_3)_2$ → 3**A** + 2**C**$(NO_3)_3$
3	**C**	**D**$(NO_3)_2$	no reaction

0 9 . 3 The ionic equation for **Reaction 1** is:

$$\mathbf{A} + 2\mathbf{B}^{+} \rightarrow 2\mathbf{B} + \mathbf{A}^{2+}$$

Why is this a redox reaction?

[1 mark]

Tick (✓) **one** box.

A gains electrons and $\mathbf{B}^{+}$ loses electrons. ☐

A loses electrons and $\mathbf{B}^{+}$ gains electrons. ☐

Both **A** and $\mathbf{B}^{+}$ gain electrons. ☐

Both **A** and $\mathbf{B}^{+}$ lose electrons. ☐

4.4.1.1 Metal oxides

Question 61 · continued

0 9 . 4 Which of the four metals has the greatest tendency to form positive ions?

Use **Table 6**.

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 9 . 5 The nitrate ion has the formula NO_3^-

Which of the four metals could be aluminium?

Explain your answer.

Use **Table 6**.

[3 marks]

Metal _____

Explanation _____

_____

_____

_____

Question 9 continues on the next page

4.4.1.1 Metal oxides

Question 61 · continued

0 9 . 6 Metal **X** is extracted from an oxide of metal **X** by reaction with hydrogen.

The equation for the reaction is:

$$\mathbf{X}O_3 + 3H_2 \rightarrow \mathbf{X} + 3H_2O$$

The percentage atom economy for obtaining metal **X** by this method is 77.3%.

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

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

[4 marks]

Relative atomic mass (A_r) = _____

12

4.4.1.1 Metal oxides

Question 62

June 2024 | 8462/2H | Original Q7

0 7 This question is about sulfuric acid.

0 7 . 1 Sulfuric acid contains sulfate ions.

Describe the test for the presence of sulfate ions in sulfuric acid.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

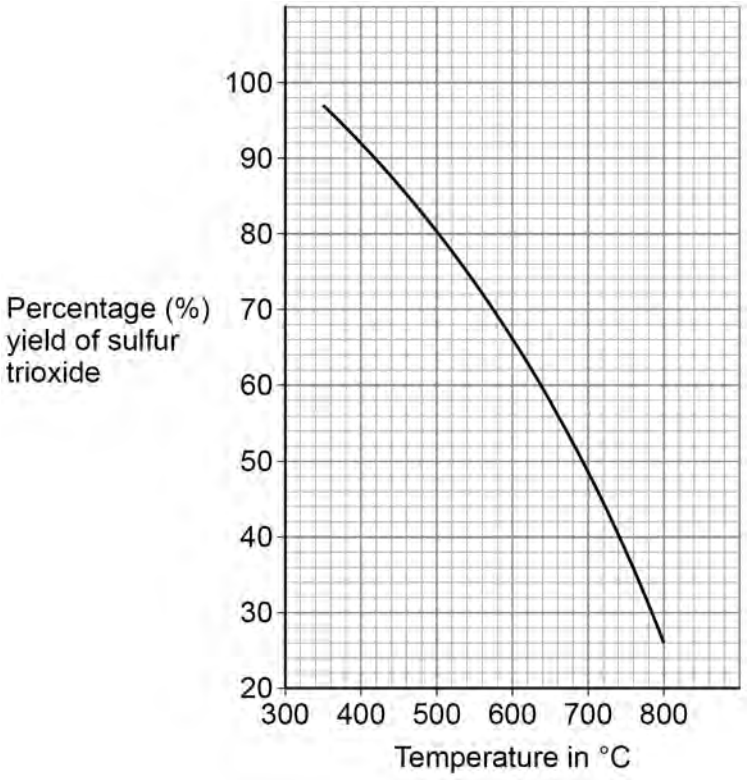
_____

One stage in the industrial production of sulfuric acid is the reaction of sulfur dioxide with oxygen to produce sulfur trioxide.

This reversible reaction reaches dynamic equilibrium.

Figure 7 shows the percentage yield of sulfur trioxide in this reaction at different temperatures.

Figure 7



4.4.1.1 Metal oxides

Question 62 · continued

0 7 . 2 Which statement about the forward reaction is correct?

Use **Figure 7**.

[1 mark]

Tick (✓) **one** box.

- The yield is greater at higher temperatures because the reaction is exothermic. ☐
- The yield is greater at higher temperatures because the reaction is endothermic. ☐
- The yield is smaller at higher temperatures because the reaction is exothermic. ☐
- The yield is smaller at higher temperatures because the reaction is endothermic. ☐

The equation for the reaction is:

$$2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g)$$

0 7 . 3 Explain why the percentage yield of sulfur trioxide in this reaction is greater if the pressure is higher.

[2 marks]

0 7 . 4 In industry, the reaction is done at 450 °C and atmospheric pressure.

Under these conditions the yield of sulfur trioxide is 86%.

Suggest **two** reasons why a higher pressure is **not** used.

[2 marks]

1

2

4.4.1.1 Metal oxides

Question 62 · continued

0 7 . 5 This reaction uses a catalyst to increase the rate of the reaction.

The catalyst is a metal oxide.

Which is the most likely metal in the metal oxide catalyst?

Use the periodic table.

[1 mark]

Tick (✓) **one** box.

Aluminium (Al) ☐

Barium (Ba) ☐

Potassium (K) ☐

Vanadium (V) ☐

8

4.4.1.1 Metal oxides

Question 63

June 2025 | 8462/1H | Original Q3

0 3 This question is about metals and metal oxides.

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

The equation for the reaction is:

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

0 3 . 1 Which substance is reduced in this reaction?

Give **one** reason for your answer.

Answer in terms of oxygen.

[2 marks]

Substance reduced _____

Reason _____

_____

0 3 . 2 Why can carbon be used to extract tin from tin oxide?

[1 mark]

_____

_____

Question 3 continues on the next page

4.4.1.1 Metal oxides

Question 63 · continued

0 3 . 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 = _____ %

0 3 . 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 63 · continued

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

0 3 . 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]

0 3 . 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

4.4.1.1 Metal oxides

Question 64

June 2025 | 8462/1H | Original Q6

0 6 Aluminium is extracted by the electrolysis of a molten mixture.

The mixture contains aluminium oxide and one other substance.

0 6 . 1 Aluminium oxide is an ionic compound.

Explain why aluminium oxide has a very high melting point.

[4 marks]

Extra space

0 6 . 2 Name the substance added to aluminium oxide to form the mixture.

[1 mark]

0 6 . 3 Give **one** reason why a mixture is used as the electrolyte.

[1 mark]

4.4.1.1 Metal oxides

Question 64 · continued

Oxygen is produced at the positive electrode.

0 6 . 4 Write the half equation for the reaction that produces oxygen at the positive electrode.

[2 marks]

_____ → _____ + _____

0 6 . 5 The positive electrode must be continually replaced.

Explain why.

[3 marks]

_____

_____

_____

_____

_____

_____

11